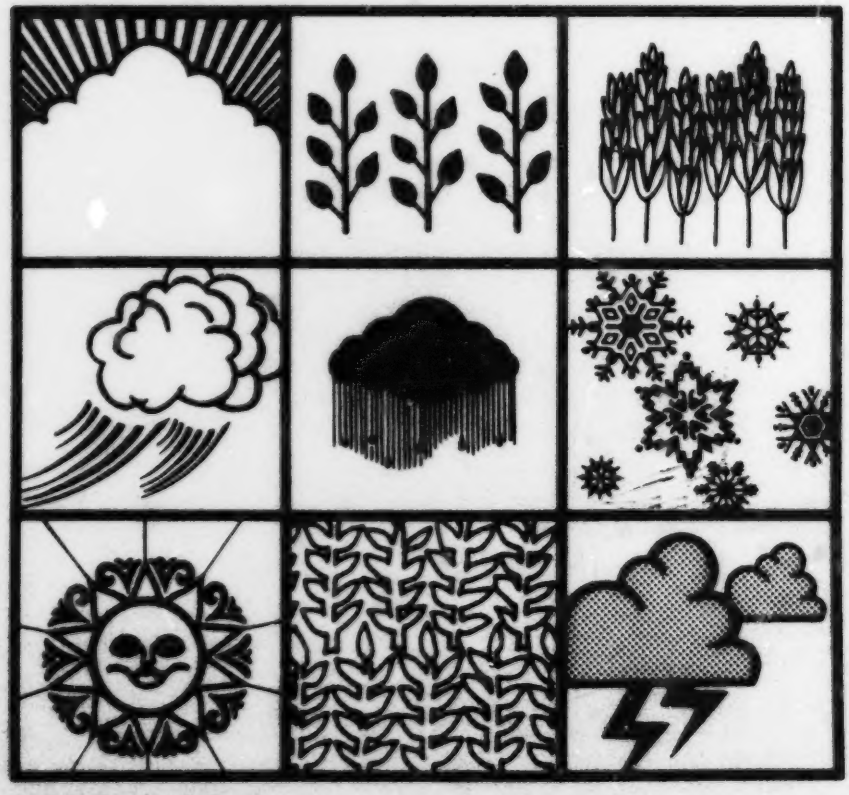
1982

SOUTHERN MANITOBA'S CLIMATE & AGRICULTURE



MANITOBA
AGRICULTURE

Southern Manitoba's Climate and Agriculture

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Introduction

Agriculture, like other sciences, is constantly acquiring new knowledge. In particular a number of new developments have occurred in agricultural meteorology, especially weather-crop growth relationships.

Climatic analysis data must be considered with a certain amount of caution. A major difficulty is that many weather stations have been established in locations where the data collected is not representative of the surrounding area. For example, a weather station located in a river valley does not provide data representative of the area outside the valley.

Another problem is the availability of data over the entire agricultural area. Since there were only 50 stations providing data for more than 20 years, two uncertainties resulted:

1. data for a period as short as 20 years may not be sufficient to characterize the climate of a location;
2. a small number of useful stations means that there may be no data for long distances so it is difficult to estimate where the most rapid changes take place (the placing of contour lines becomes arbitrary).

The density of stations used in the analysis varies from region to region (Figure 1), being greatest south of 51 degrees north latitude. The most precise contour locations on the maps is in the most southerly part of the province. The more northerly regions are less precise.

The maps provided, do not show the changes in climate that occur with significant changes in topography over short distances. The maps also do not show, for example, that river valleys are more likely to experience frost than areas outside the valleys. There are two reasons for these omissions:

1. there is insufficient information to describe such effects quantitatively,
2. inclusion of such information complicates reading the maps.

Map contours are labelled so there is no ambiguity as to the value of a parameter at a location exactly on the contour. There are instances, when it is uncertain if the values are increasing or decreasing as we move away from the contour. To resolve this ambiguity a commonly used climatology convention was adopted. It calls for the orientation of the label to determine whether the value is increasing or decreasing away from the contour. For example, if a horizontal contour is labelled such that the value is upright, the value of the parameter increases as one moves up from the contour, and decreases as one moves down from the contour. If the label on the contour was upside down, the values of the parameter would increase as one moves down from the contour, and decrease as one moves up from the contour. Similarly the direction of change for any orientation of a contour can be assessed.

Spring, Autumn Frost and Frost Free Period

Frost is of obvious significance to agriculture; plants are either damaged or killed by frost. Spring frosts are important because they determine the date of planting; autumn frosts determine the last day on which growth takes place. The frost free period is the most important because it is the time available for crop production. This, combined with a knowledge of crop requirements, determines what crops can be grown in a given region. The number of days required to mature the most important crops grown in Manitoba is given in Table 1.

Table 1.

Number of days required for various crops to grow to maturity

Wheat	90 - 100	Barley	60 - 90
Oats	85 - 88	Flax	85 - 100
Buckwheat	80 - 90	Yellow Mustard	80 - 90
Brown or Oriental Mustard	85 - 95	Corn (grain)	110 - 120
Canola-late Argentine	92 - 102	Canola — early Polish	73 - 83
Field peas	90 - 100	Lentils	85 - 100
Canary grass seed	95 - 105	Navy Beans	90 - 100
Sunflowers	120 - 130	Sugar Beets	120 - 140
Coriander	90 - 100	Fababeans	105 - 115
Black Beans	95 - 105		

Interpretation of frost data in relation to the number of days required to grow a particular crop must be done cautiously. A crop such as Navy beans is easily damaged by frost. In this case frost should be defined as 0ºC. Since sugar beets can withstand a light frost, a temperature of -2.2ºC is a better definition of frost.

Data for the last spring frost at 0ºC (Figure 2) shows that the area surrounding Portage la Prairie is the most favorable region. After May 20, there is only a 50 per cent chance of frost. This favorable condition is at least partly due to the moderating influence of Lake Manitoba on Portage's climate. In most of the province, the last spring frost at 0ºC occurs after May 25 every one out of two years.

The 25 per cent risk map (Figure 3) again shows the areas around Portage la Prairie and Morden to be the most favorable. Much of the province can expect a 0ºC frost to occur after June 4 one out of every four years. When the frost risk is reduced to 10 per cent (Figure 4), the general pattern of dates of occurrence is the same as for the 25 per cent and 50 per cent (average) maps. In a large part of the province a spring frost can occur later than June 9 one out of every 10.

Maps showing the date of the last spring frost at -2.2ºC display the same general pattern as those for the 0ºfrost. Again Portage and Morden are the most favorable areas, with the last spring frost occurring before May 10 in one of every two years (Figure 5). As the risk of frost at -2.2ºC is reduced, the date it takes place is later in the spring (Figures 6 and 7). The Interlake and the region to the west of Riding Mountain can expect a -2.2ºC frost in June one year out of every 10.

The map showing the average date for the first autumn frost of 0ºC indicates that those areas which have a late spring frost usually have an early autumn frost (Figure 8). For example, Portage la Prairie has the earliest last spring frost and the latest first autumn frost. Generally, the western part of the province is the least favorable with respect to first autumn frost. When the risk of frost is reduced to 25 per cent (Figure 9), the date it occurs is earlier, but the date in one region relative to another shows the same geographical distribution. The 10 per cent risk

map of first autumn frost shows that many areas in Manitoba can expect the first autumn frost at 0ºC to occur in August one year of every 10 (Figure 10).

The average date for the first autumn frost at -2.2ºC (Figure11) is 10 days later that at 0ºC. Again, the Portage la Prairie and Morden areas are the most favorable, while the western part of the province is the least favorable.

The data for the 25 per cent and 10 per cent risk values indicate earlier dates but a geographical distribution similar to that of 50 per cent risk or average date of occurrence (Figures 12 and 13).

The map showing the average length of the frost free period, that is, the number of consecutive days above 0ºC (Figure 14), again illustrates the suitability of the Portage area for agriculture. The Red River Valley is the next best with frost free periods in about 120 days. The areas to the west of the Escarpment are not as good, having frost free periods ranging from 105 to 115 days.

Reducing the risk of the frost free period above 0ºC to 25 per cent reduces its length at Portage to 115 days (Figure 15). A significant portion of Manitoba, particularly to the west of the escarpment, has a frost free period of less than 100 days one year in every four. This makes the production of crops such as sunflowers, corn, fababeans, Black beans and Navy beans quite risky. (Table 1 shows the frost free day requirement of these crops). One year in every four the frost free period would be too short to mature these crops.

The average length of the frost free period above -2.2ºC is shown in Figure 17. The Portage la Prairie and Morden areas are the most favorable with more than 145 consecutive days above -2.2ºC. There is a noticeable decrease in the length of this period west of the Manitoba Escarpment. As expected, more northerly areas also have noticeably shorter frost free periods. Another area with a short frost free period above -2.2ºC is the south-east corner of the province. The 25 per cent and the 10 per cent risk maps (Figures 18 and 19, respectively) show much lower values but the same relative distribution.

Figure 1. Meteorological Stations Utilized in this Research.

Figure 2. Average Date of Occurrence of the Last Spring Frost (0°C).

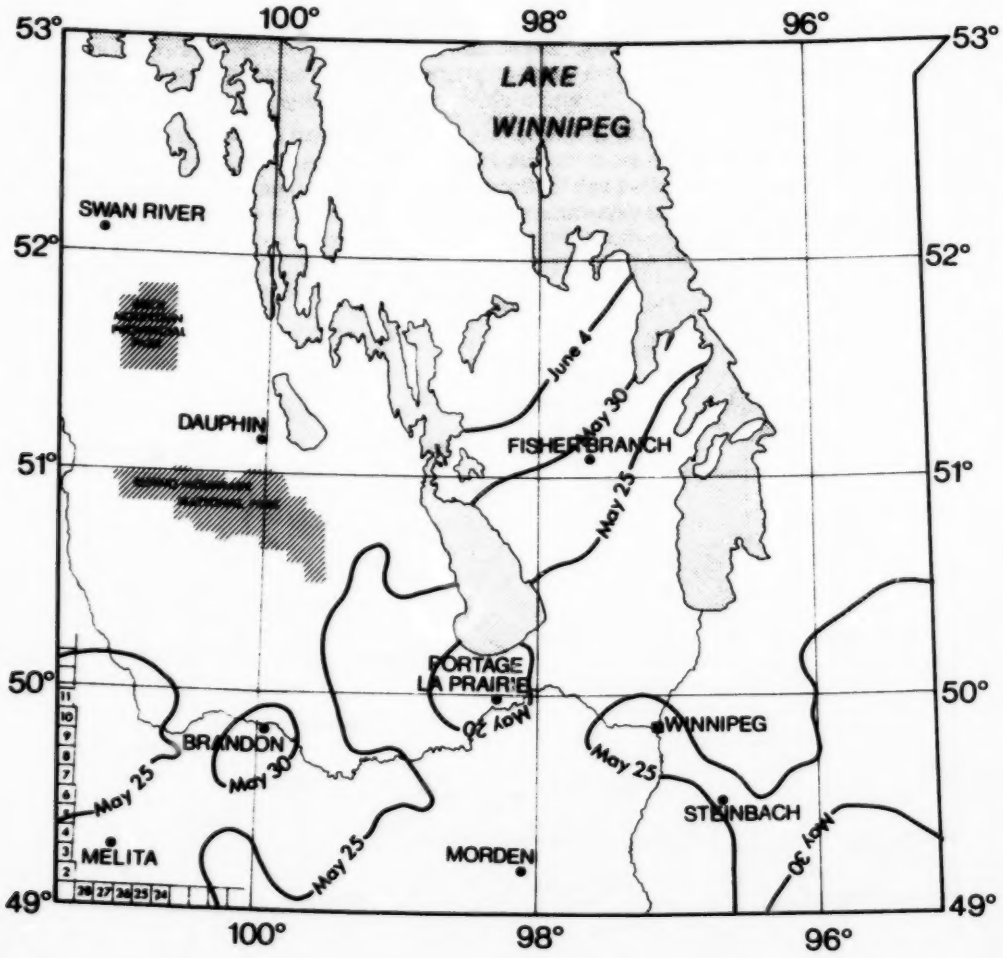


Figure 3. Dates after which the Risk of Occurrence of the Last Spring Frost (0°C) has been reduced to 25%.

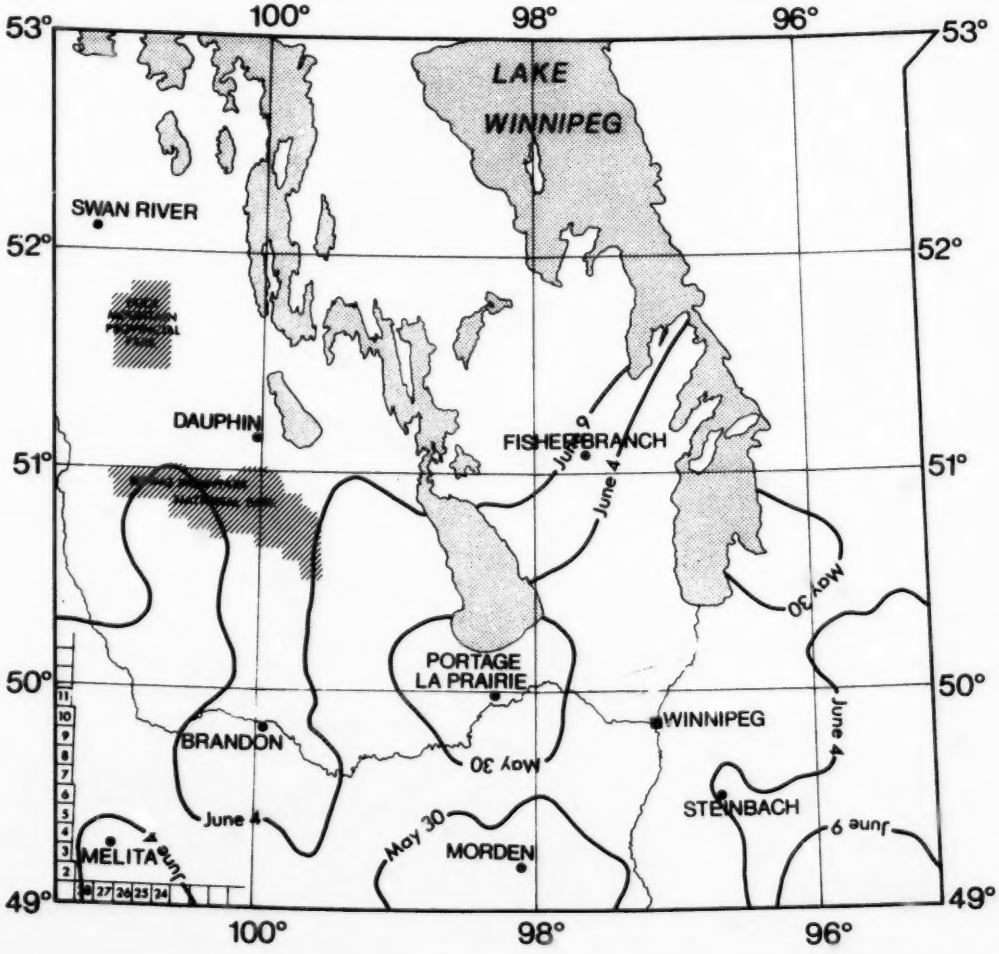


Figure 4. Dates after which the Risk of Occurrence of the Last Spring Frost of 0°C has been reduced to 10%.

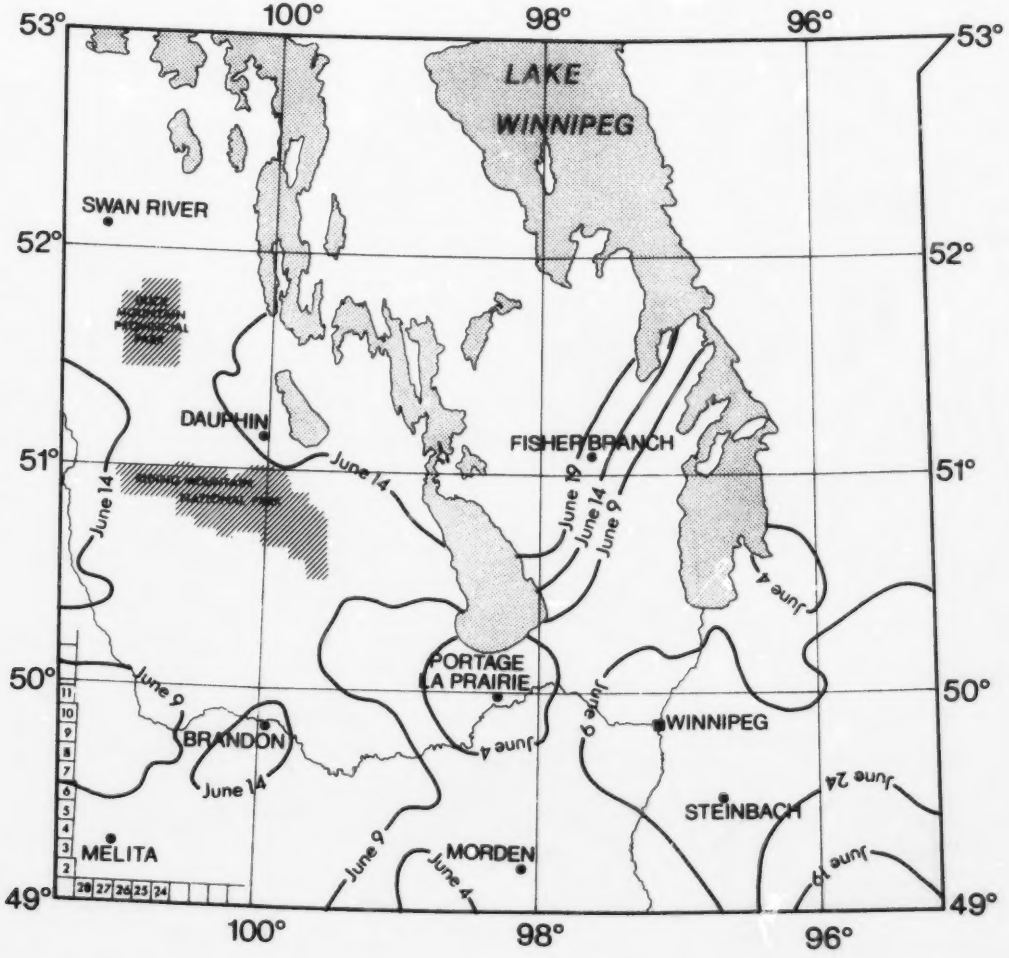


Figure 5. Average Date of Occurrence of the Last Spring Frost (-2.2°C).

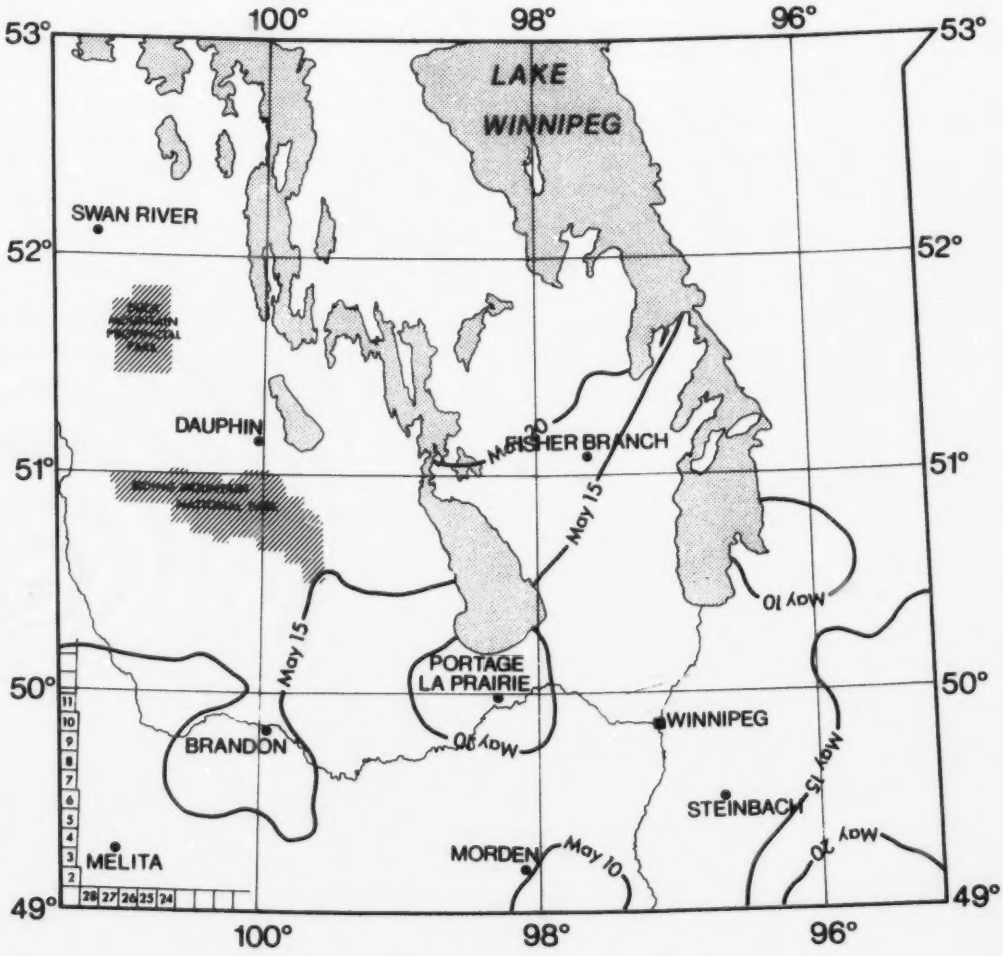


Figure 6. Dates after which the risk of occurrence of the Last Spring Frost (-2.2°C) has been reduced to 25%.

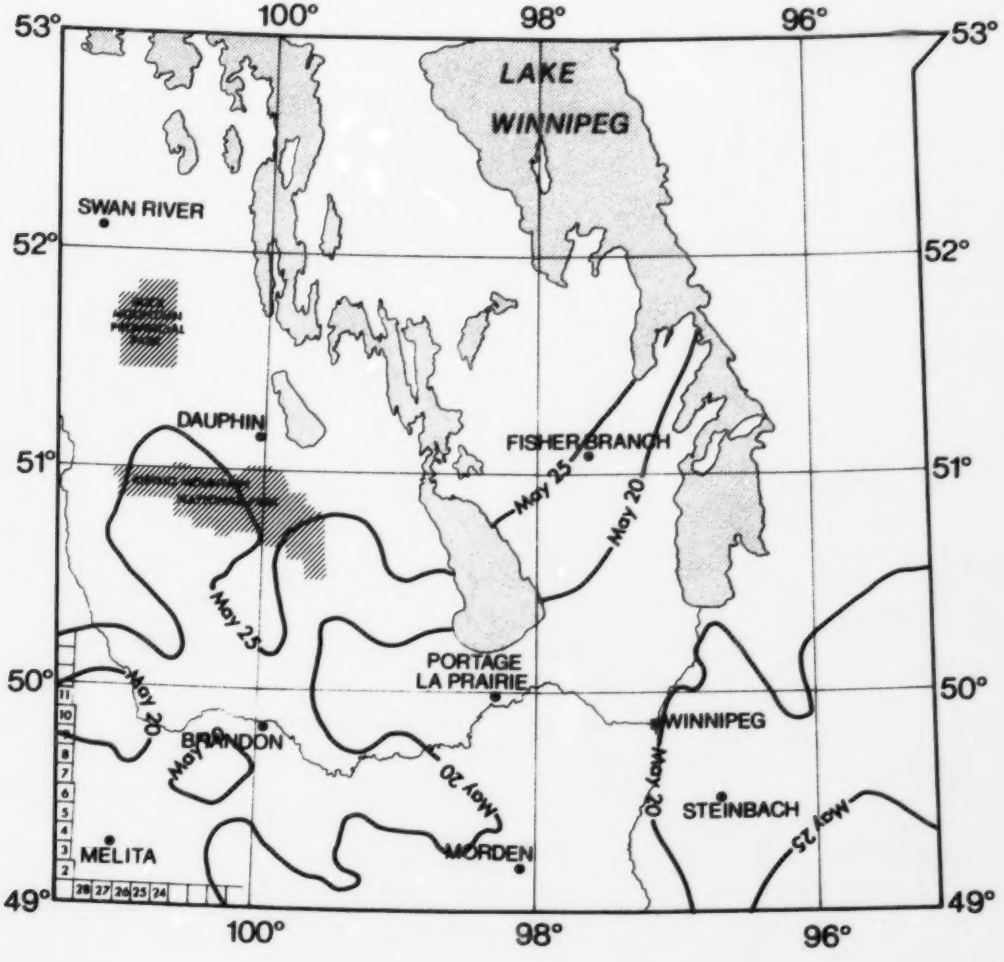


Figure 7. Dates after which the risk of occurrence of the Last Spring Frost (-2.2°C) has been reduced to 10%.

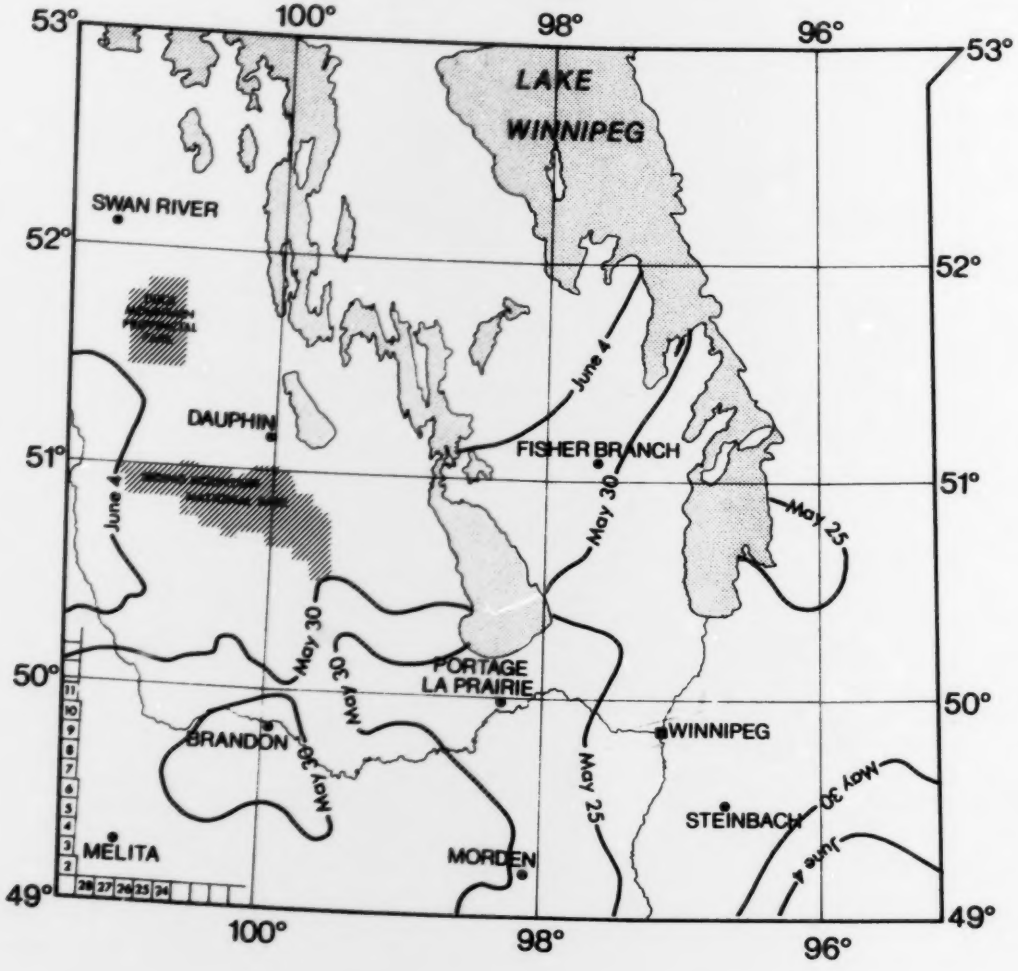


Figure 8. Average Date of Occurrence of the First Fall Frost (0°C).

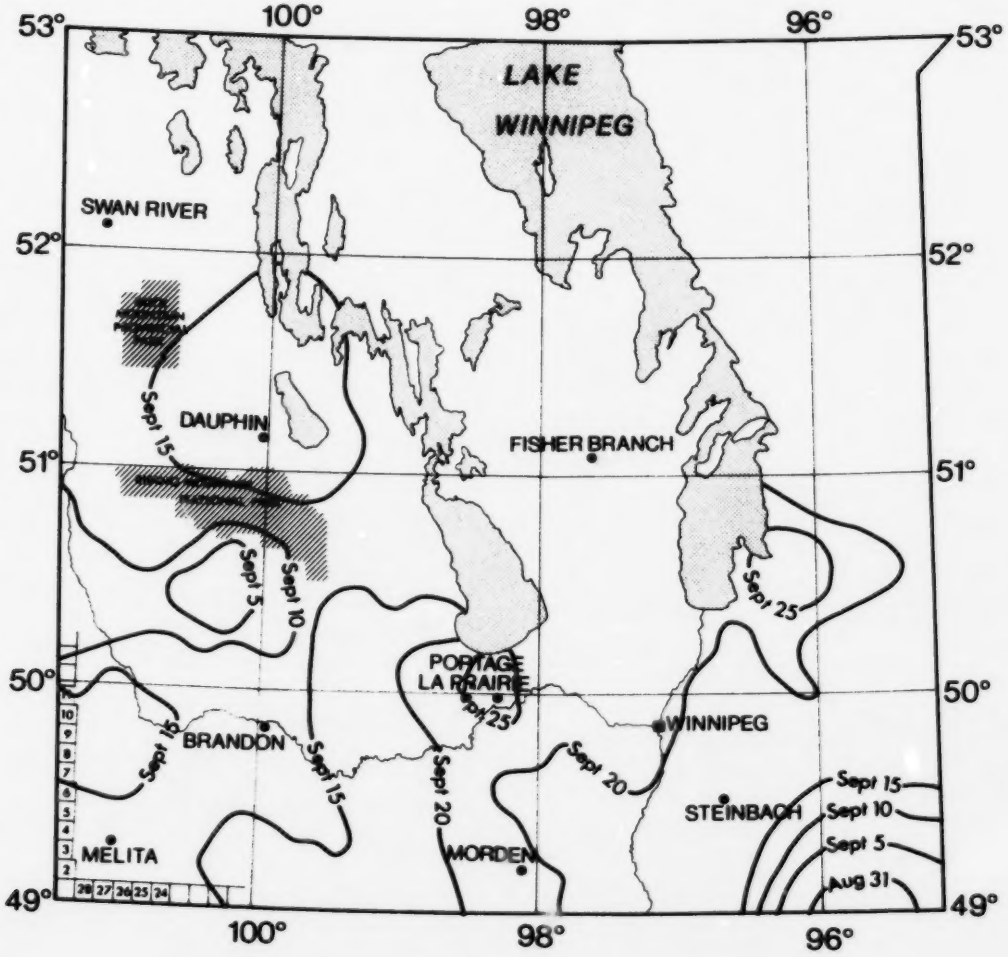


Figure 9. Dates before which the occurrence of the First Fall Frost (0ºC) is at a 25% risk.

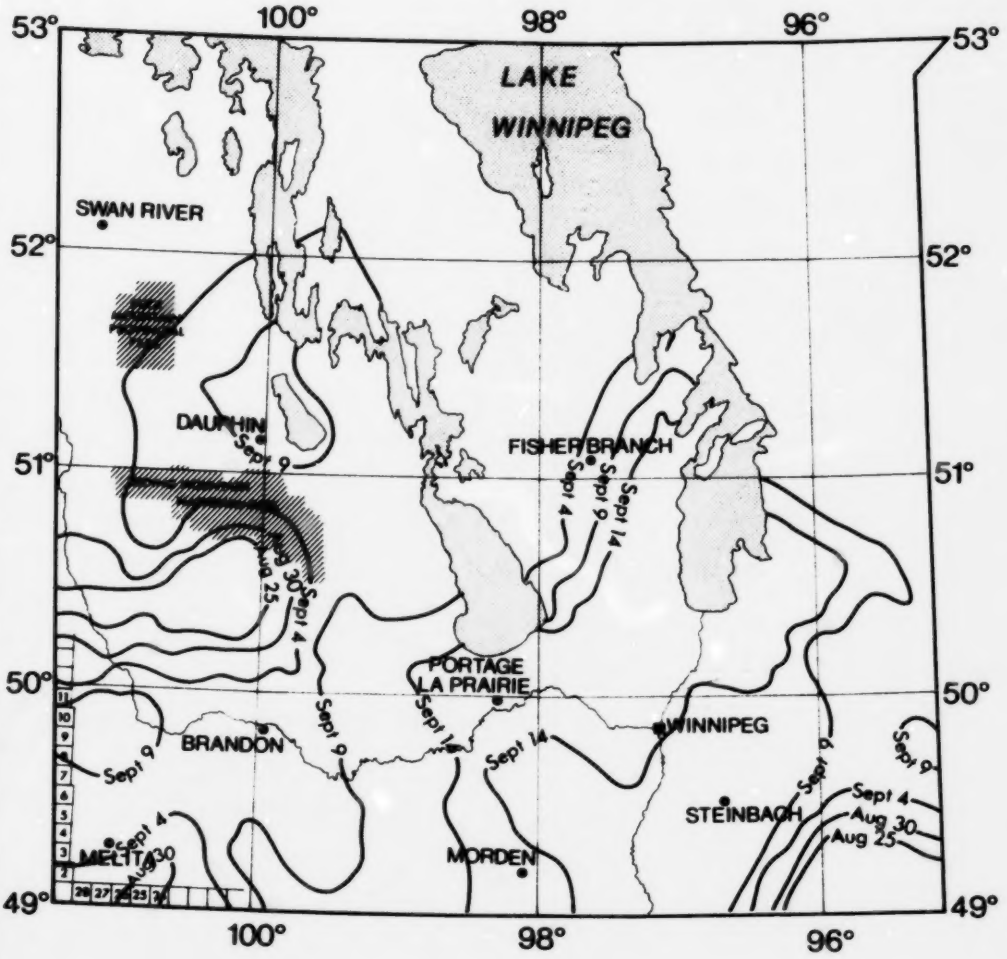


Figure 10. Dates before which the occurrence of the First Fall Frost (0°C) is at 10% risk.

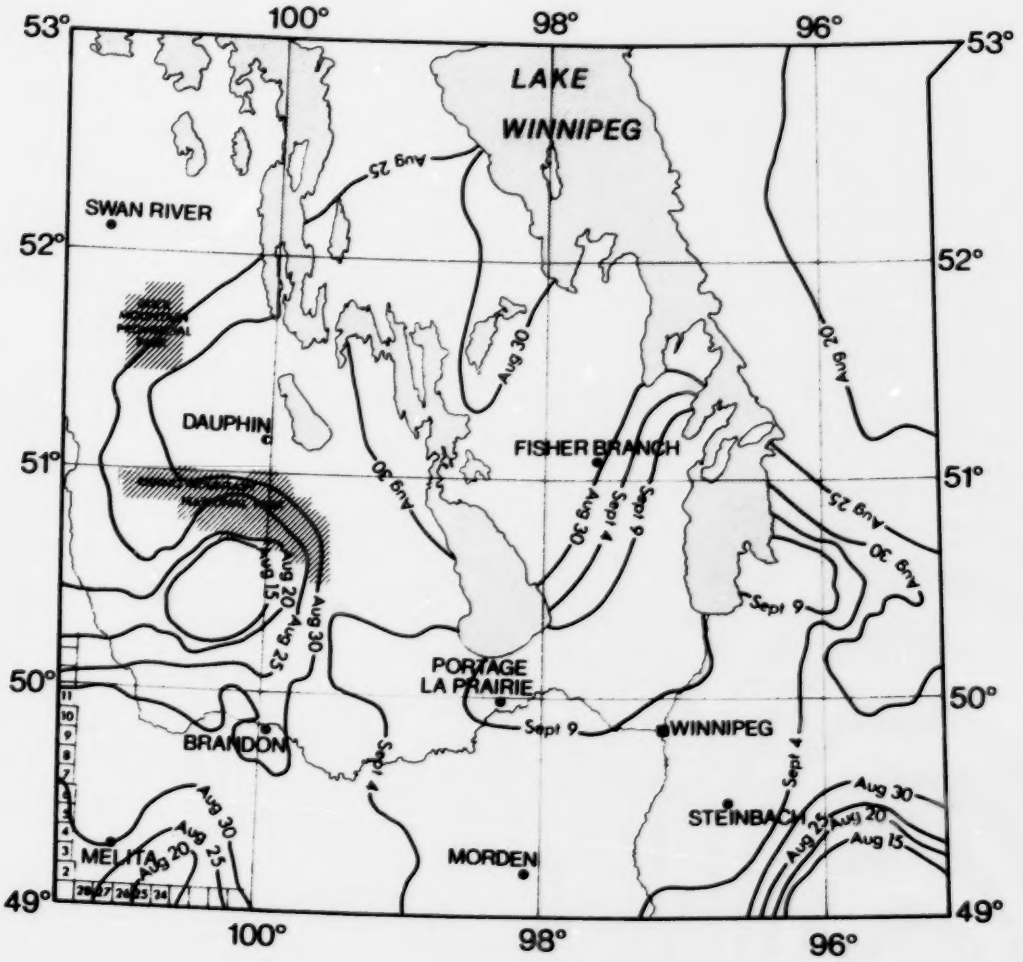


Figure 11. Average date of occurrence of the First Fall Frost. (-2.2°C).

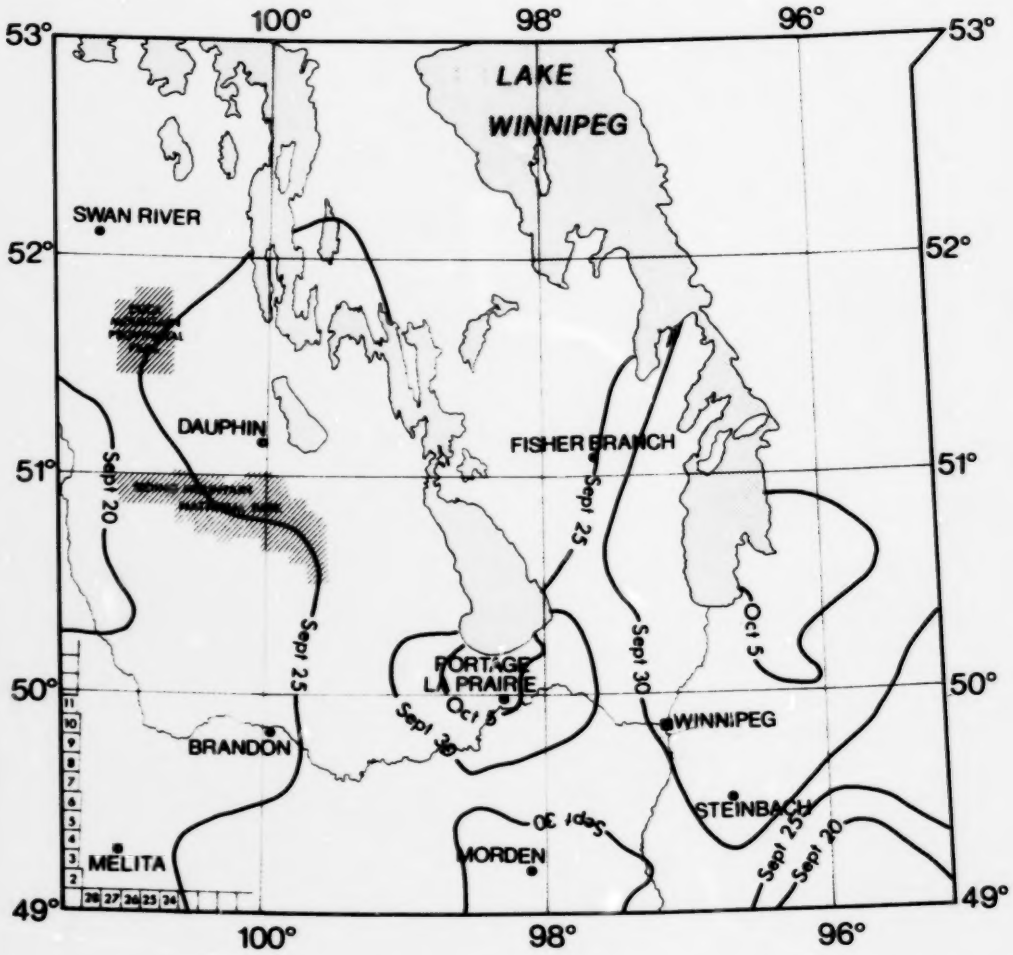


Figure 12. Dates before which the occurrence of the First Fall Frost (-2.2°C) is at a 25% risk.

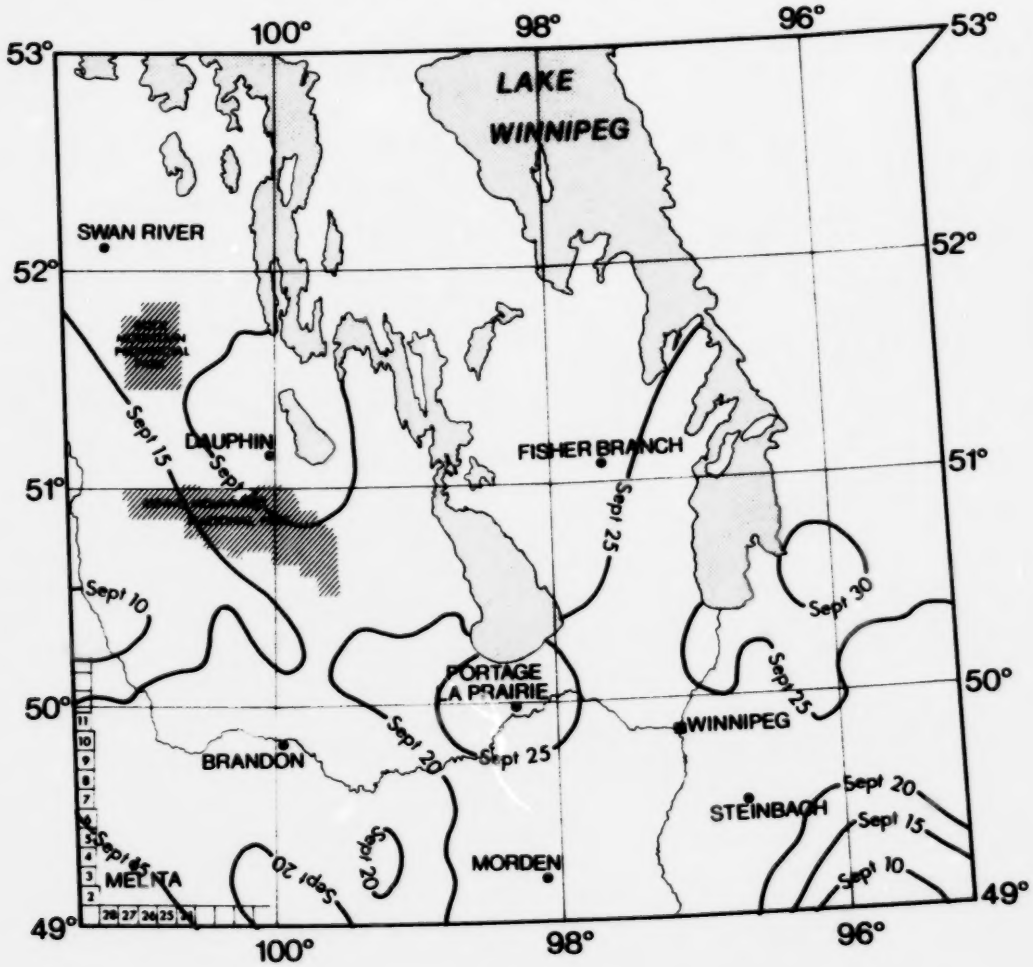


Figure 13. Dates before which the occurrence of the First Fall Frost (-2.2°C) is at a 10% risk.

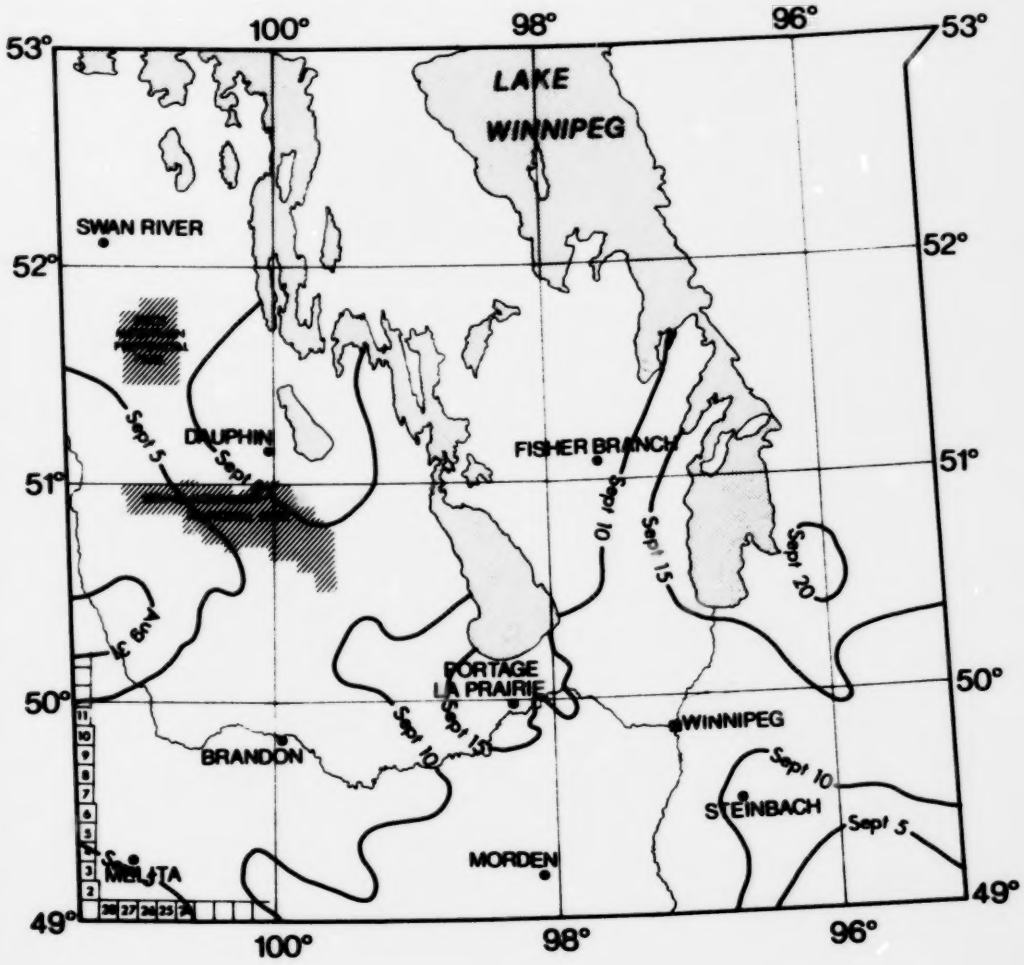


Figure 14. Average Length of the Frost-Free Period above 0°C.

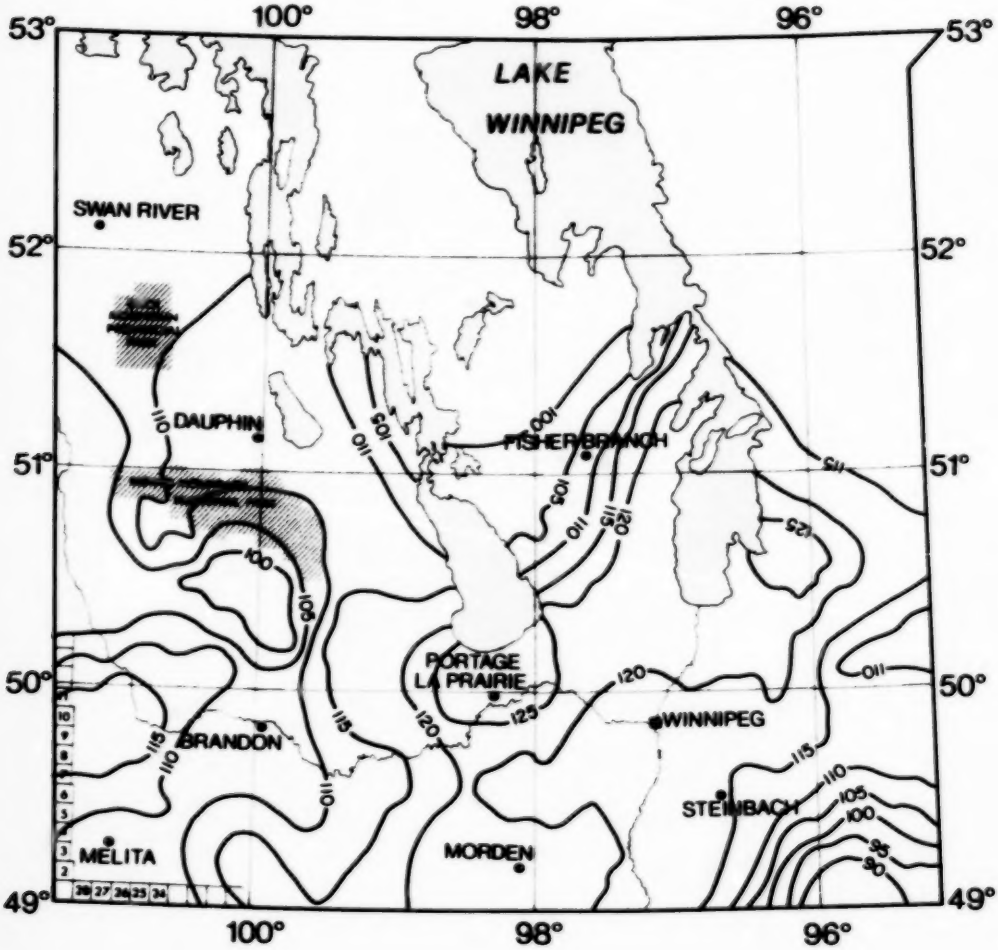


Figure 15. Length of the Frost-Free Period (0°C) at a 25% risk.

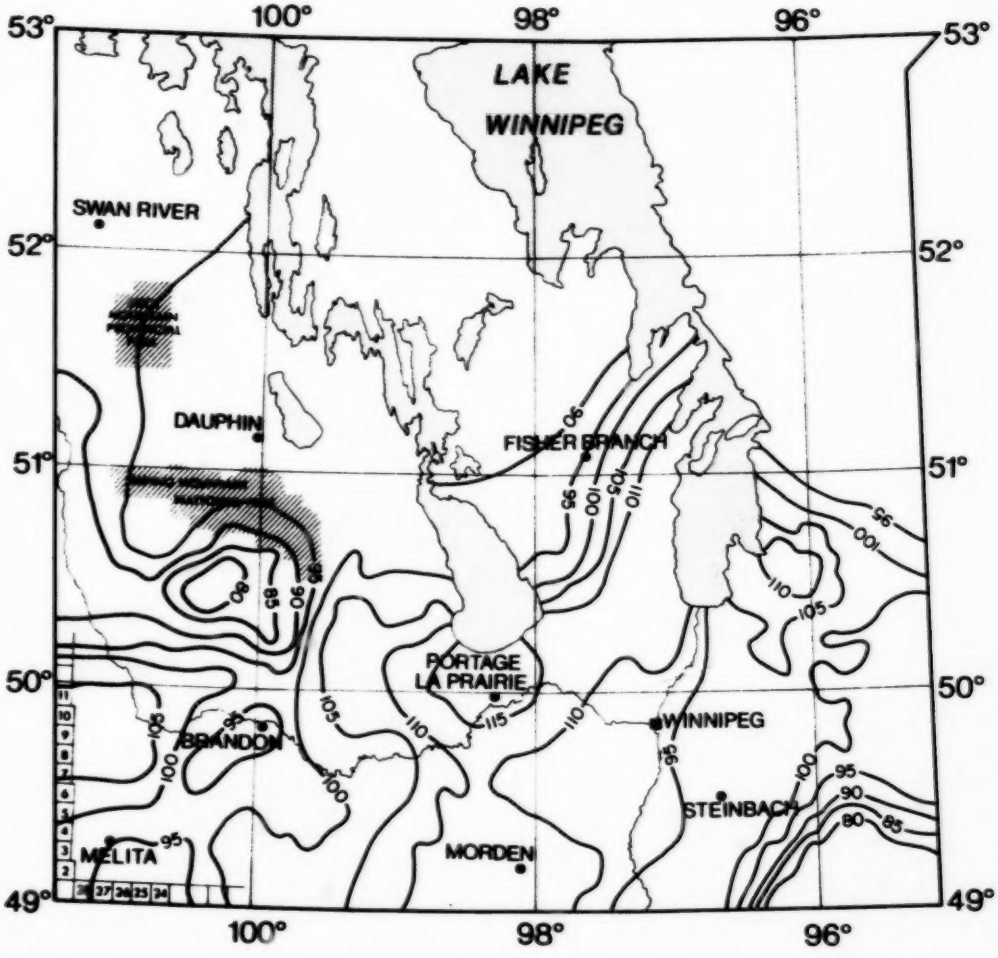


Figure 16. Length of the Frost-Free Period above 0°C at a 10% risk.

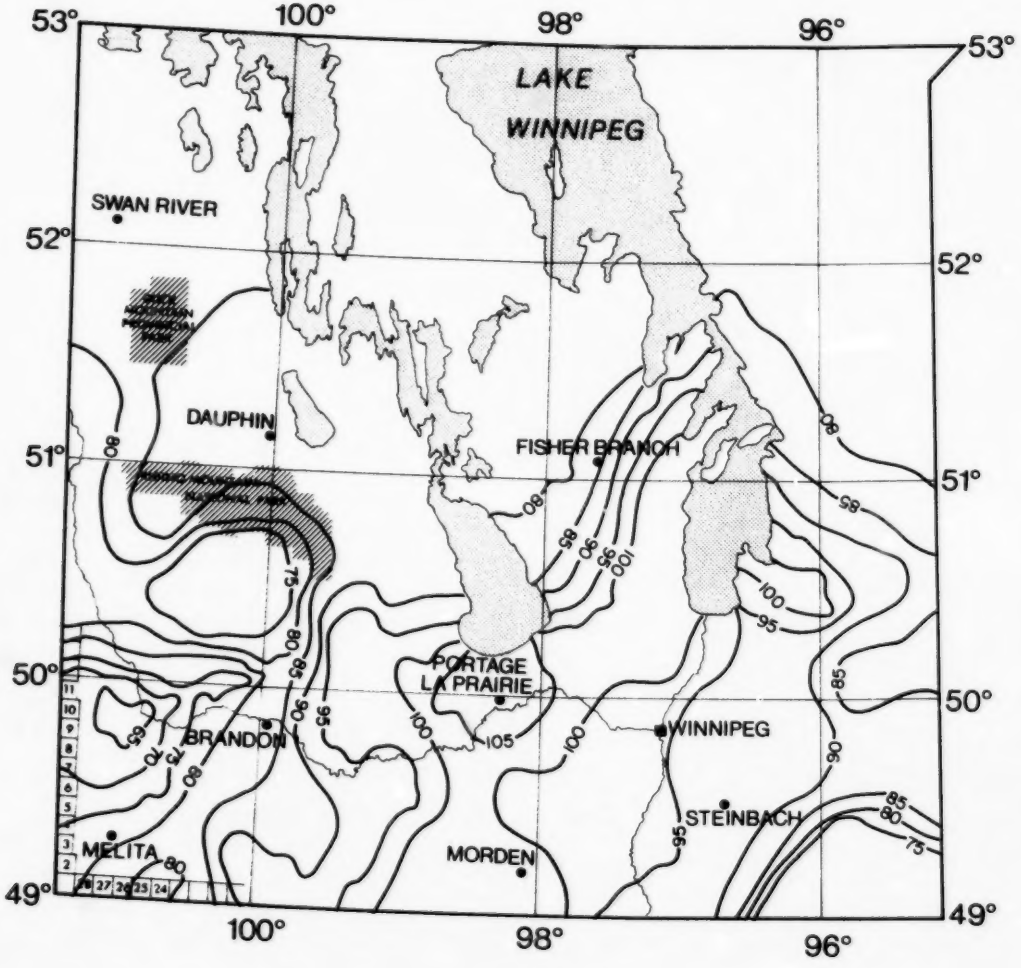


Figure 17. Average Length of the Frost-Free Period above -2.2°C.

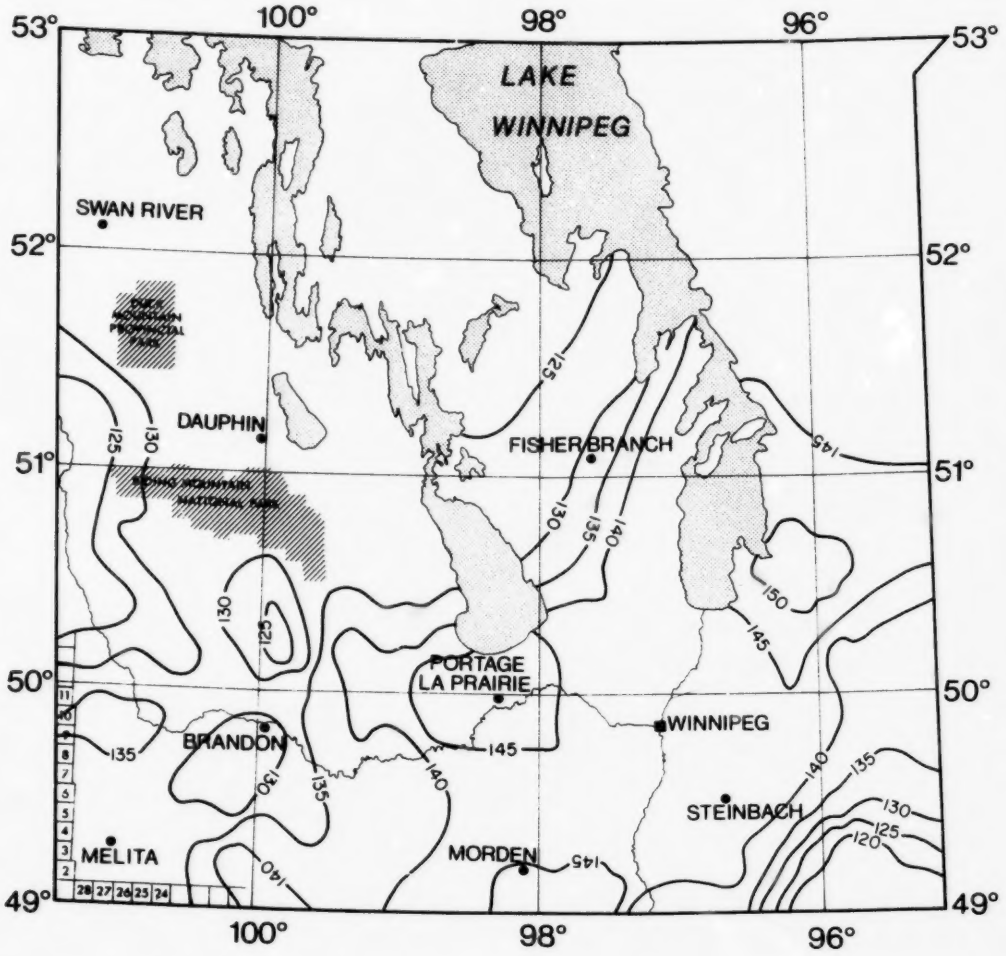


Figure 18. Length of the Frost-Free Period (-2.2°C) at a 25% risk.

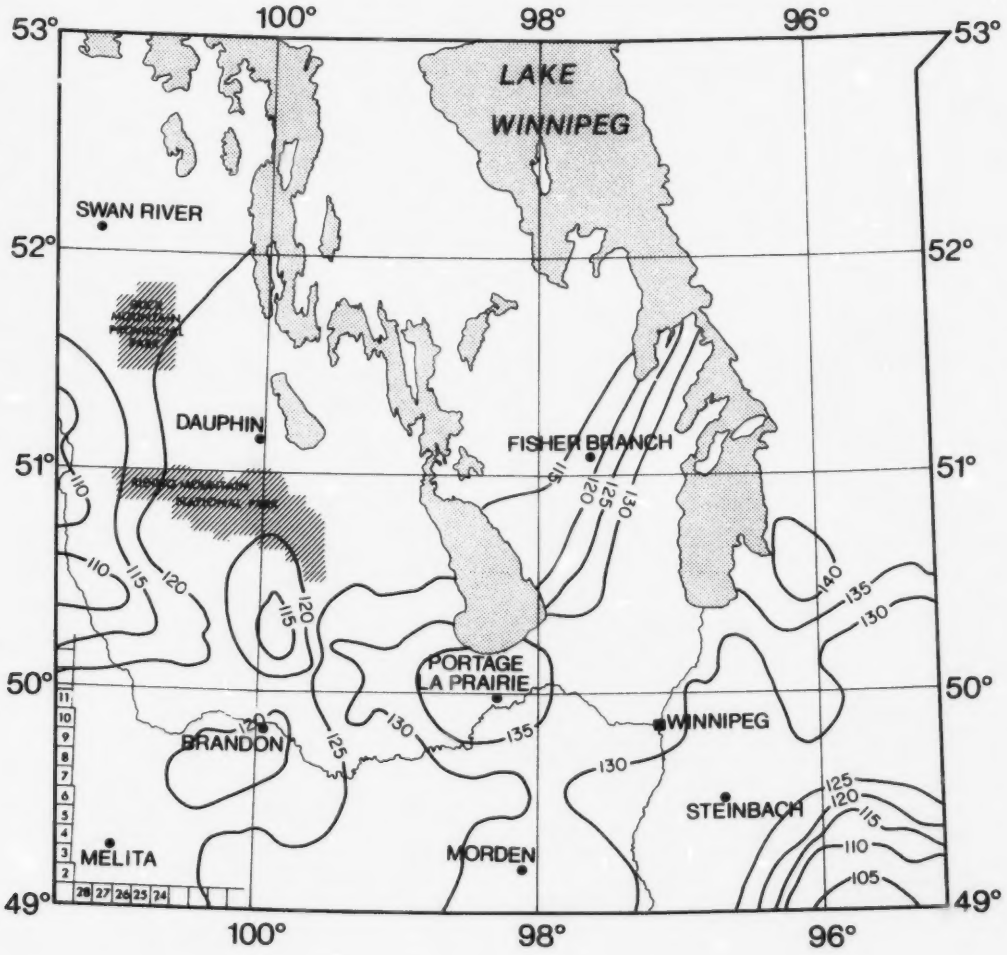
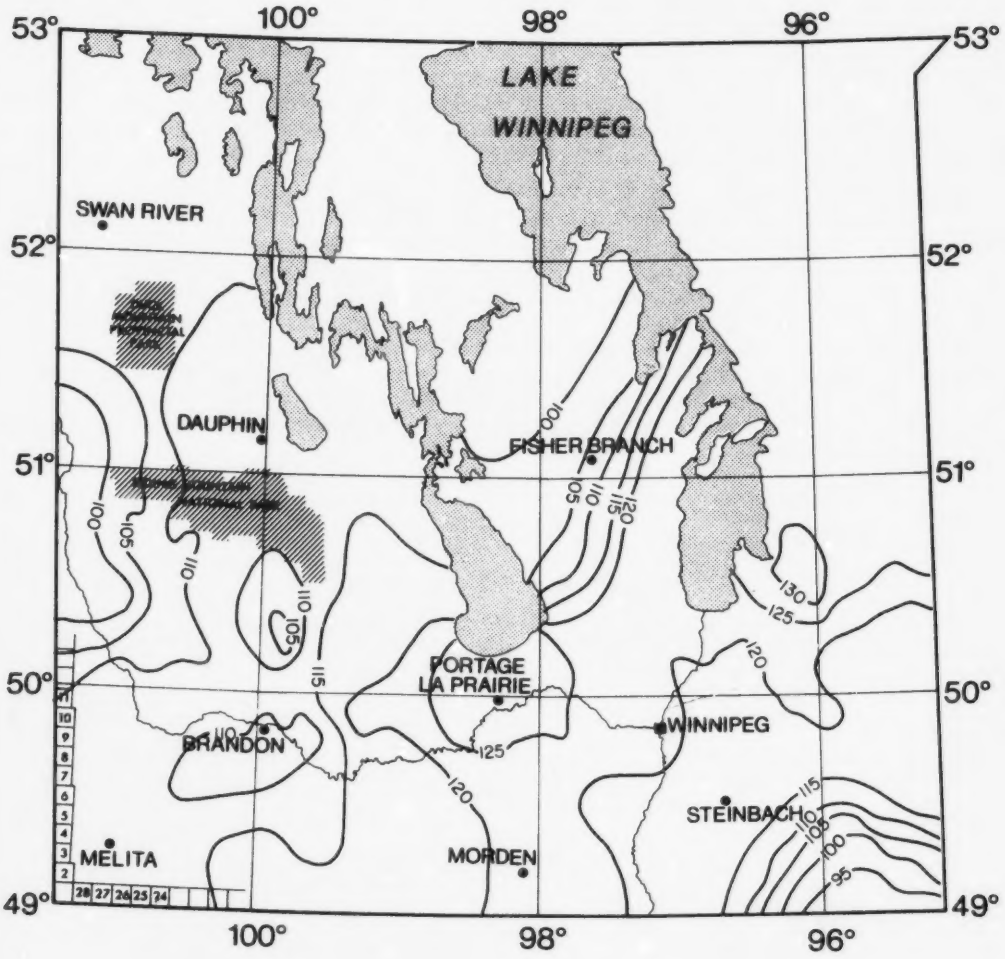


Figure 19. Length of the Frost-Free Period (-2.2°C) at a 10% risk.



Degrees Days Above 5°C

Plant growth depends upon the ambient temperature. Growth starts at some minimum temperature and, for most cereals, this is about 5°C. As temperature increases, rate of plant growth increases, until an optimum temperature is reached. Increases in temperature beyond this point decrease growth rate.

In the degree-day system, detrimental effects of high temperature are ignored. It is believed that in the temperature regions where the system is used, temperatures do not reach sufficiently high levels to justify the additional complications in calculation.

Calculation of degree days is a relatively simple procedure. The minimum and maximum temperatures for the day are averaged to obtain a daily mean. The difference between this mean temperature and 5°C is defined as the degree days accumulated for that day. These are calculated for each day of the growing season and summed to give an accumulated degree days for the growing season.

Originally, the concept of degree days was used to assess the suitability of an area to a particular crop. A crop requiring an accumulation of 1200 degree days above 5°C to reach maturity can be grown in all areas having 1200 or more degree days above 5°C. There is also some evidence that yield and protein content of cereals and rapeseed, as well as oil content of rapeseed, are influenced by degree days above 5°C. In some special crops, knowledge of degree day accumulation throughout the season is used in planting schedules. The idea is to ensure that harvest dates are not too close to each other, so as to provide a steady supply of product.

The average degree days above 5°C in the period May 1 to September 30 shows a maximum of 1700 in the Morden, Morris-Emerson area, a minimum of 1400 in the Riding Mountain and Birtle-Russell areas (Figure 20). Data such as this may be used to establish crop suitability to a particular area. For example, wheat requires about 1200 degree days above 5°C, 200 less than that available in the lowest region. Examination of the 25 per cent risk map shows the lowest degree day accumulation to be about 1300 (Figure 21). The 10 per cent risk map has as its lowest accumulation 1200 degree days above 5°C (Figure 22). On the basis of these maps, in the area studied, one should be able to mature wheat (which requires 1200 degree days to mature) more than 90 per cent of the time. As degree day requirements of the new crops are established, it will be possible to assess the risks involved in growing these crops by consultation with these maps.

Figure 20. Average Accumulated Number of Growing Degree Days.

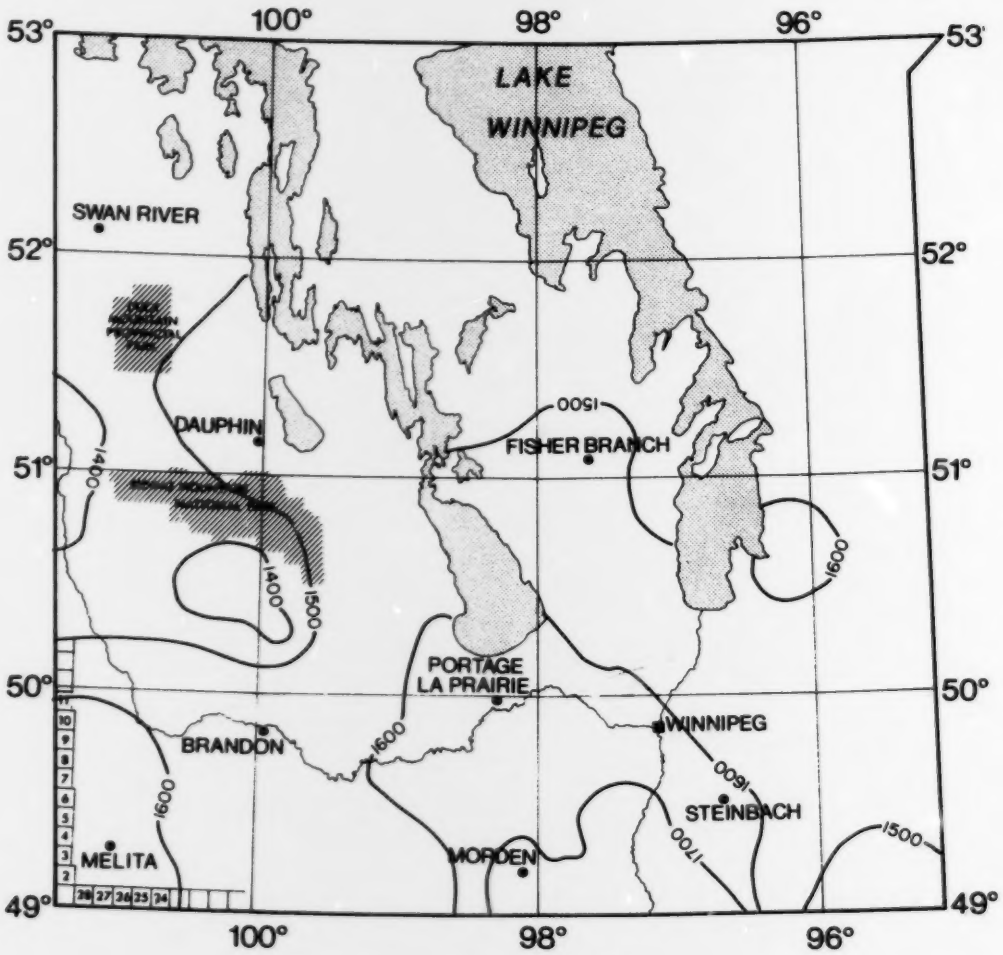


Figure 21. Minimum Accumulation of Growing Degree Days at a 25% Risk.

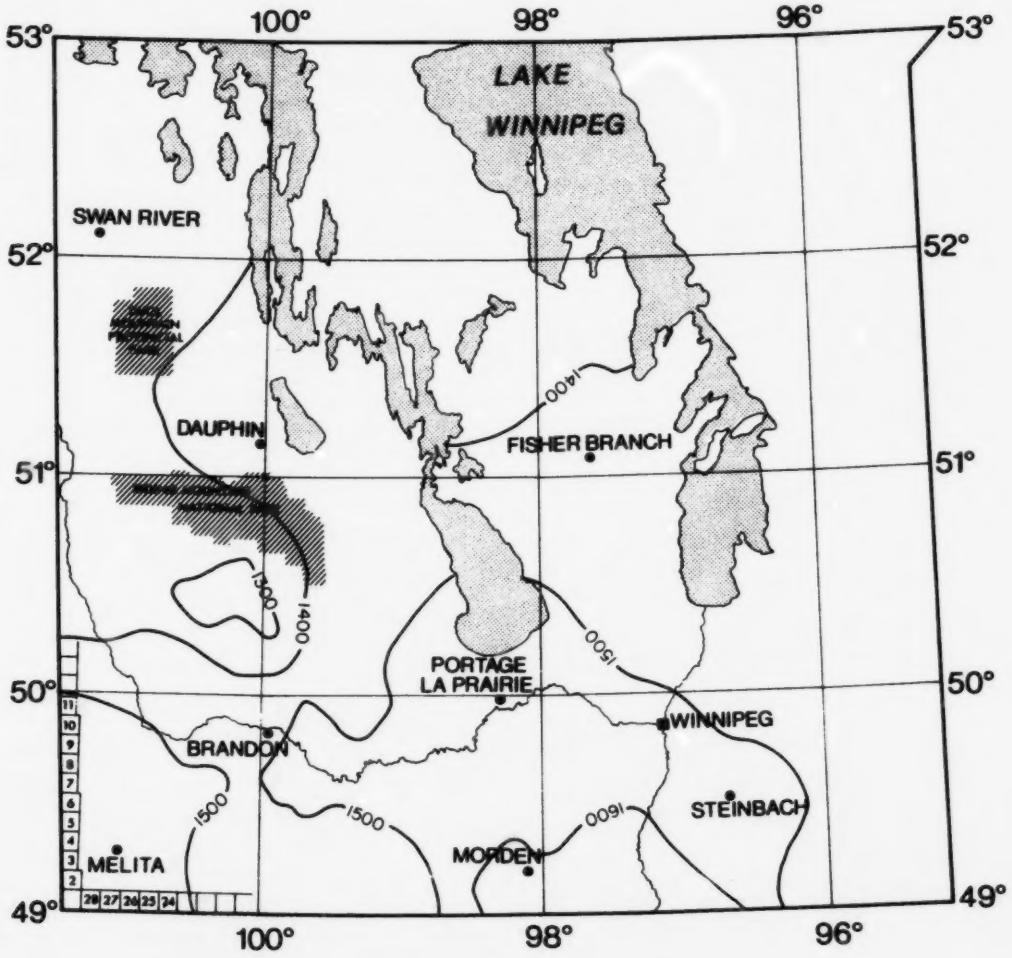
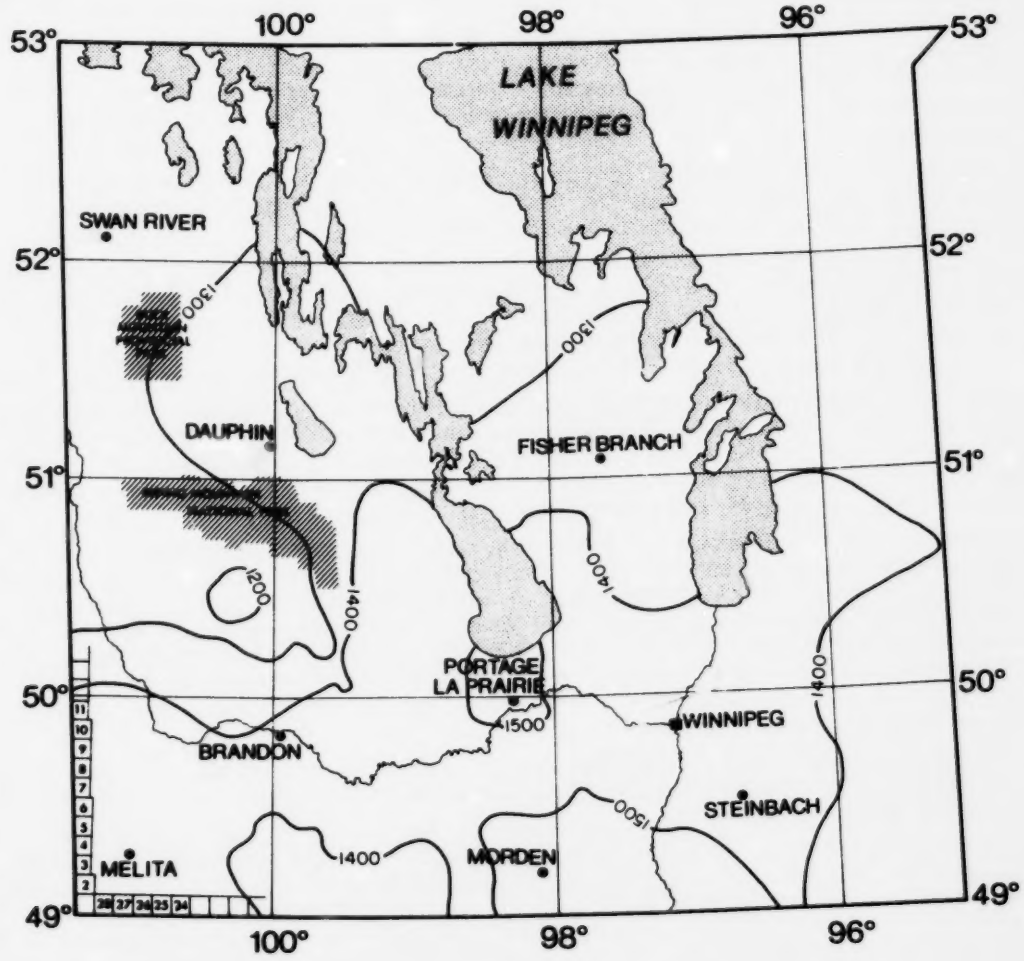


Figure 22. Minimum Accumulation of Growing Degree Days at a 10% Risk.



Corn Heat Units

The climate requirements of some crops have been studied in more detail. Such is the case with corn. The basic concept of the corn heat unit calculation is the same as the degree day calculation. The rate of plant growth is assumed to increase with increasing temperature. The major difference with corn is that no growth takes place at night temperatures below 4.4°C or day temperatures below 10°C. Where the degree day system assumes growth rate to be a linear function of temperature, the corn heat unit system assumes a curvilinear relationship in which maximum growth occurs at 30°C and decreases with higher temperatures.

The algebraic form of the relationship for calculating corn heat units (CHU) is:

$$CHU = \frac{1.8\,(Tmin - 4.4) + 3.33\,(Tmax - 10) - .084(Tmax - 10)^2}{2.0}$$

Tmin and Tmax are the low and high temperatures (C) for the day. Corn heat units are accumulated over the growing season in the same way as degree days. In this work, corn heat unit calculation began on May 15 and ended with the first -2.2°C frost in autumn.

The corn heat unit is used primarily to estimate the potential of an area for grain corn production. Varieties are categorized by the number of heat units that must be available from planting to maturity. Thus, each variety has a corn heat unit rating. If a hybrid has a corn heat unit rating of 2400, then an area must receive at least that many heat units for the variety to reach maturity for grain.

The highest concentration of grain corn production in Canada is in southern Ontario but these varieties do not do well in Manitoba. The climate there is much more favorable for corn production and, as a result, long season varieties with high corn heat unit ratings are grown there.

It should also be noted that the corn heat unit requirements of a hybrid in Manitoba is different from that in Ontario. For these reasons, corn growers should refer to "Field Crop Recommendations for Manitoba" which is published annually and gives up-to-date information on hybrids recommended for Manitoba. Each hybrid is rated based on trials in Manitoba. The procedure for choosing a hybrid is described in the above mentioned publication.

The map for the average corn heat unit accumulation shows that the most favorable area for corn production is south of Lake Manitoba between the Manitoba Escarpment and the eastern edge of the Red River Valley (Figure 23). The average accumulation in this area is about 2500 corn heat units. As one moves west and north, corn heat unit accumulations decrease, with the area west of Riding Mountain averaging only 2100 corn heat units.

Decisions on whether to grow corn for grain and what hybrid to choose should be based on the risk maps. The 25 per cent risk map (Figure 24) shows where 2300 CHU varieties will mature three years out of four which is the area south of Lake Manitoba between the Manitoba Escarpment and the eastern edge of the Red River Valley. Farmers living west of the Escarpment and south of the Assiniboine River should use hybrids with a CHU rating of 2200 or less to have the same chance of the corn maturing. At present, there are no hybrids with CHU ratings less than 2150. Therefore, at the 25 per cent risk level corn for grain cannot be recommended in areas north and west of Brandon.

The 10 per cent risk map shows only the area bounded by Morden, Portage, Winnipeg and Steinbach where successful grain corn production with currently available hybrids can be expected nine years out of 10 (Figure 25).

The corn heat unit maps can also be used as a guide to choosing silage hybrids. It's usually assumed that the heat unit requirement for silage is 200 units less than that for grain since silage is harvested before it reaches full maturity. Hybrids requiring 200 more heat units than a rating for a farm may be used in silage production. For example, 2400 heat unit hybrids may be used in a 2200 heat unit area. The risk maps may be used to assess risk in silage corn production in a fashion similar to that outlined for grain corn.

Figure 23. Average Accumulated Number of Corn Heat Units.

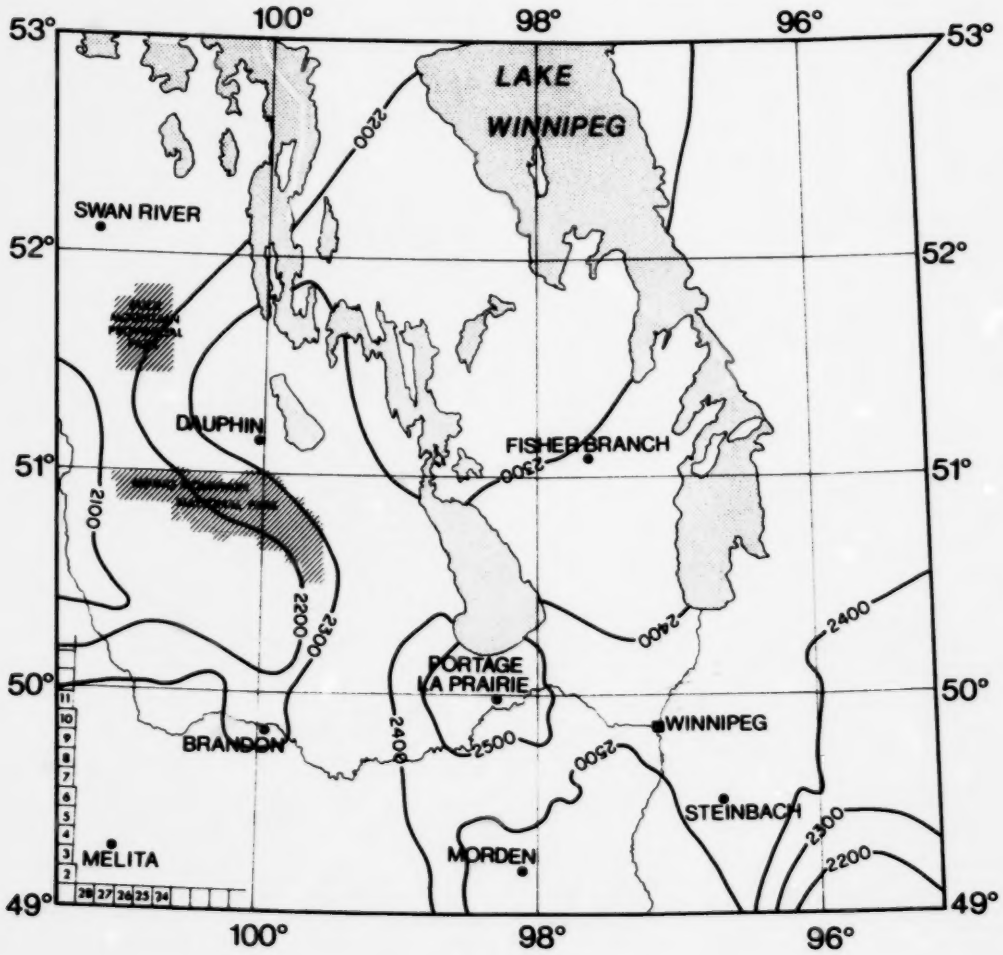


Figure 24. Minimum Accumulation of Corn Heat Units at a 25% Risk.

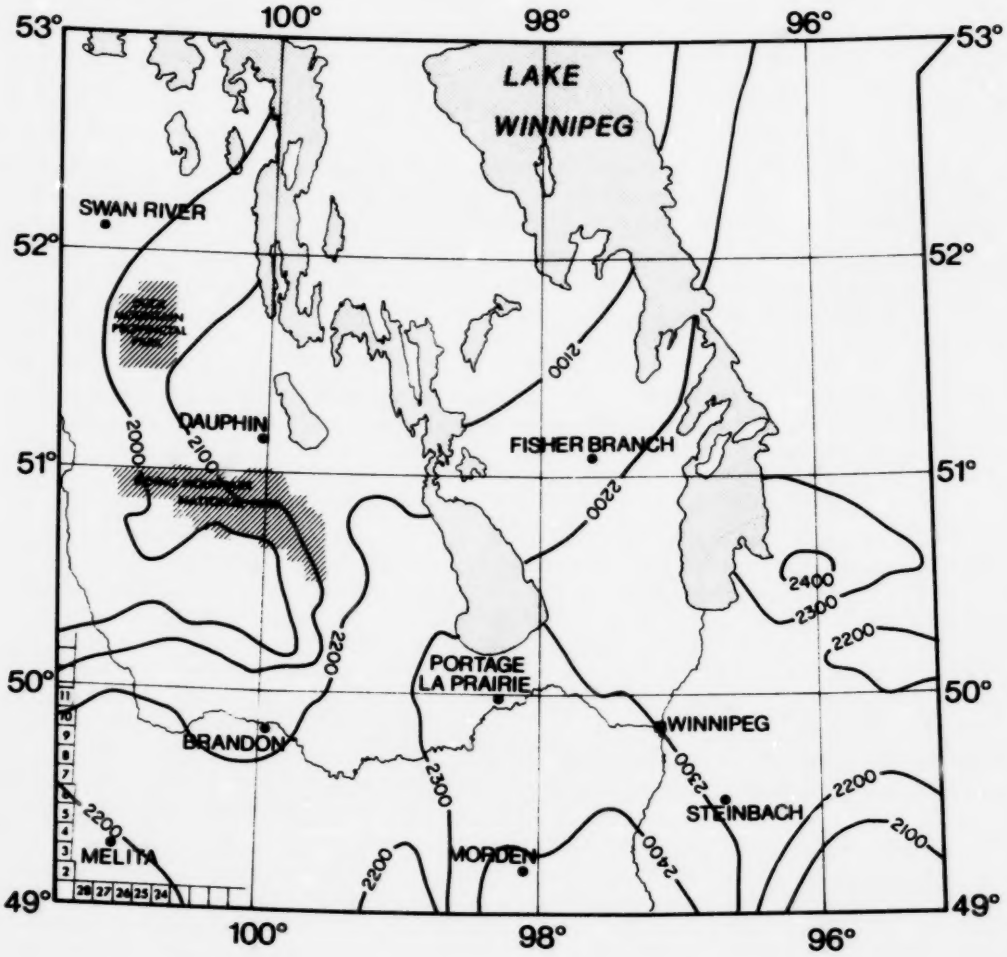
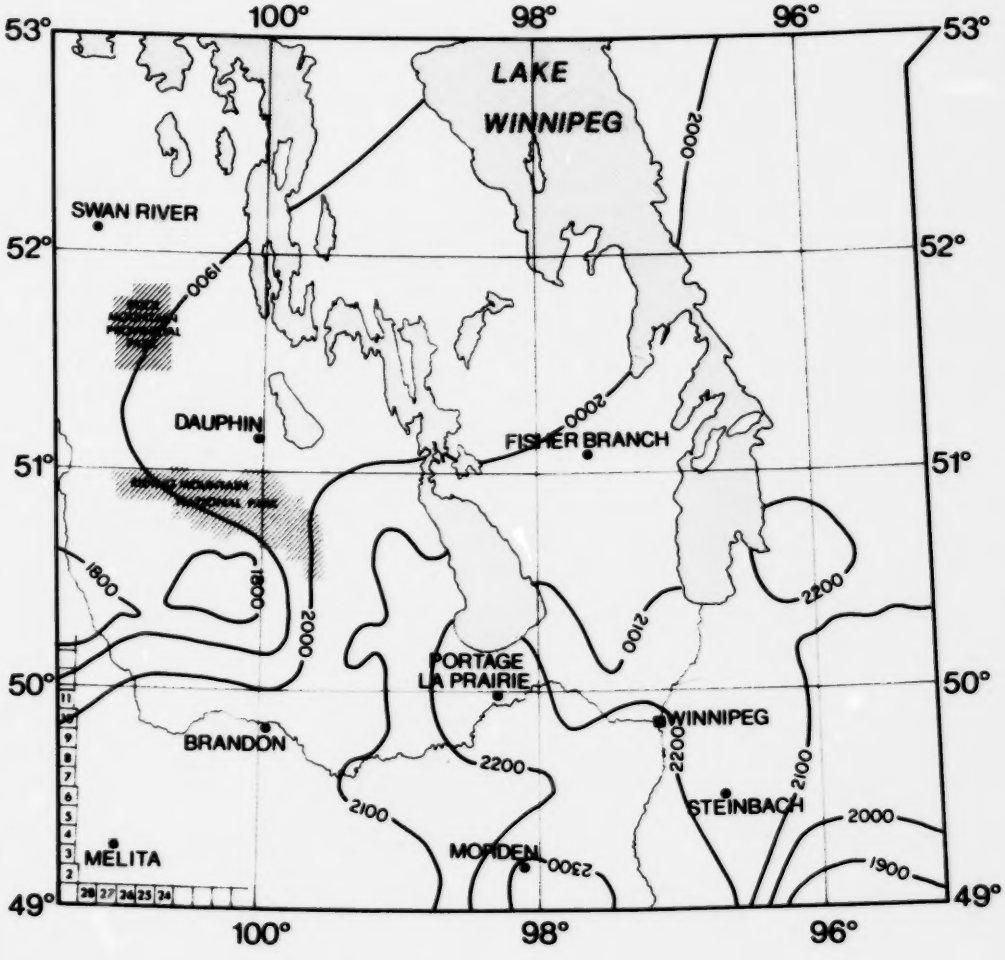


Figure 25. Minimum Accumulation of Corn Heat Units at a 10% Risk.



Growing Season Precipitation

Along with stored soil moisture in the spring, one of the most important factors affecting crop yield is precipitation during the growing season. By adding these two components, an estimate may be made of the total amount of water available for plant growth. Although the amount of water required for a given yield is not the same in all places where the crop is grown, the amount of precipitation which is presumed to fall between May 1 and September 30, is still an important parameter to agriculture.

The map showing the average amount of the growing season precipitation (Figure 26) shows very little variation. Most of Manitoba receives about 325 mm of precipitation during the growing season. Over the whole of the agricultural area in Manitoba the largest difference between any two locations is just over 50 mm. The wettest area is the south-east corner while the driest areas are in the west and southwest.

Even though the variation in average precipitation from area to area within the province is small, the year to year variation is quite large. An attempt to illustrate this fact has been made by constructing 25 per cent risk maps of "wet" and "dry" years. Figure 27 indicates the maximum amount of precipitation that would occur in the driest 25 per cent of the years under study. For example, if one considered 40 years of data, the amount of precipitation for 10 of those years would be equal or less than that shown in Figure 27. The difference between these values and the average (Figure 26) is in the order of 75 mm which is larger than the area to area variation of the average.

A serious problem in Manitoba is that often we get too much precipitation over the growing season through flooding during the growth period or excessive rainfall at harvest. An attempt to illustrate the magnitude of this problem is given in Figure 28. This map shows the minimum amount of precipitation that would occur in the wettest 25 per cent of the years. Thus, if we considered 40 years of data, 10 years would have growing season precipitation greater than or equal to the amounts shown. A comparison of Figures 27 and 28 leads one to the conclusion that during the wettest 25 per cent of the years we receive on average, about twice as much precipitation as we do during the driest 25 per cent of the years. Clearly the variation in annual growing season precipitation is a major deterrent to the stability of agriculture production in Manitoba.

Figure 26. Average precipitation (mm) for the period May 1 to September 30.

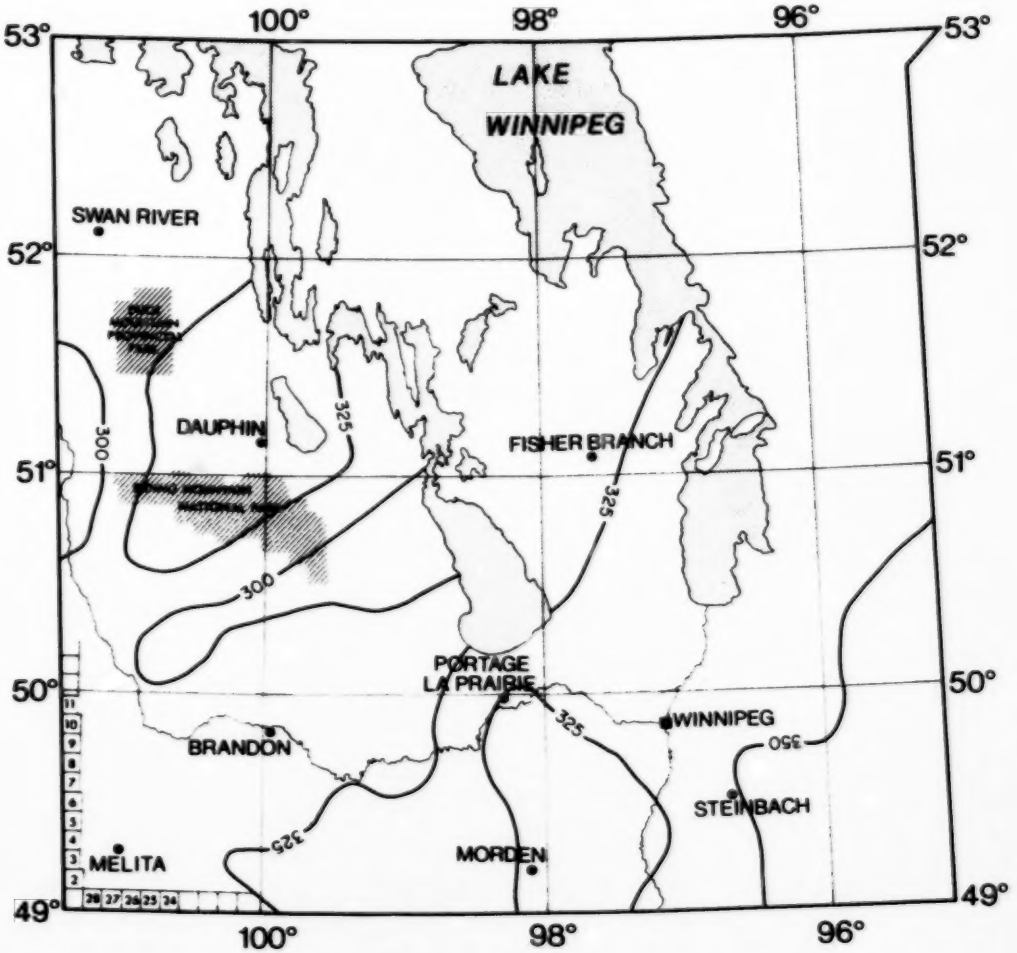


Figure 27. The 25% risk map for dry years (May 1 to September 30 precipitation). Over the long term, one year in four will have this much or less precipitation.

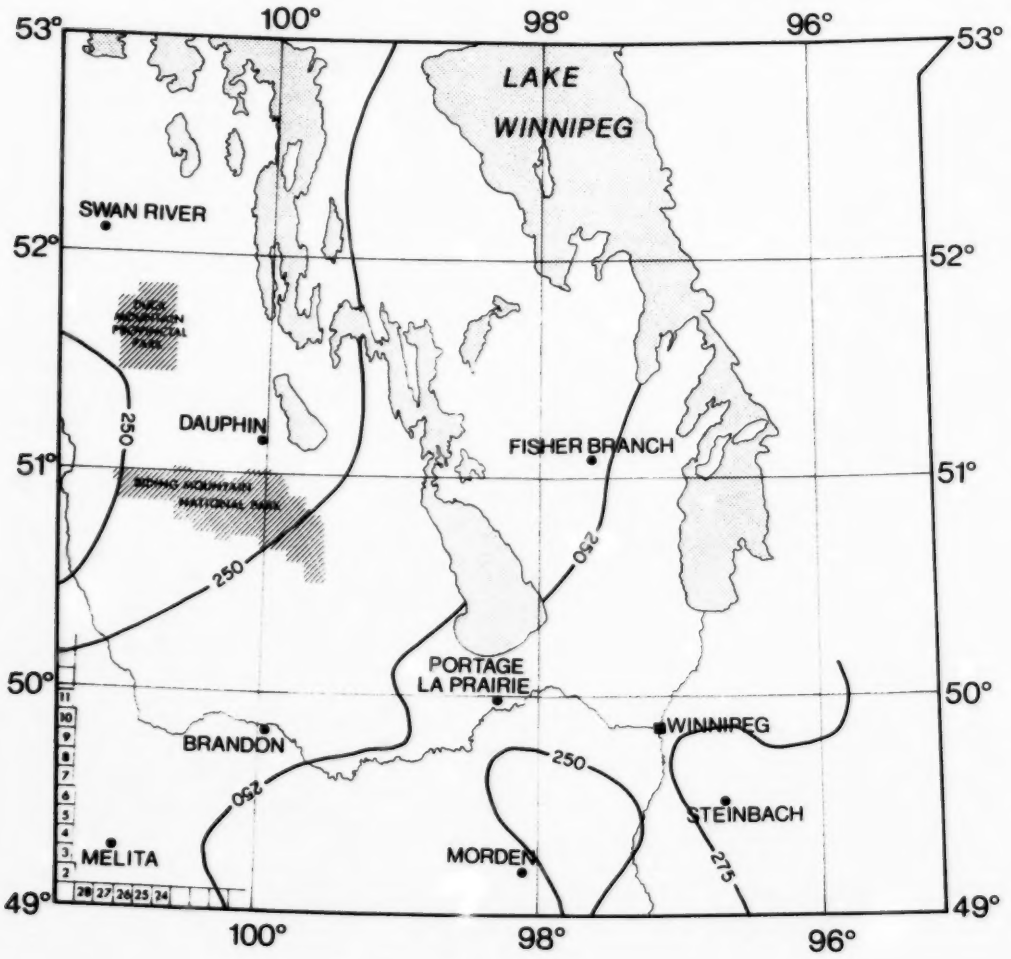
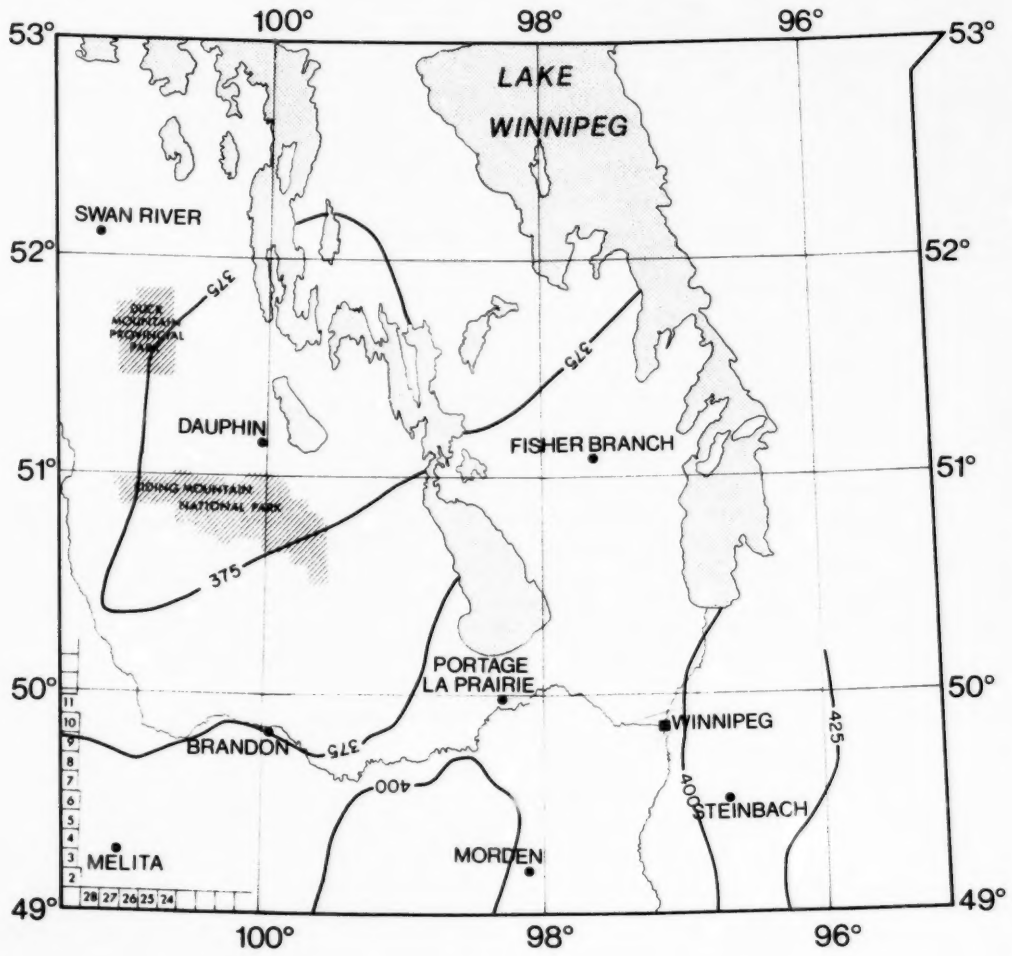


Figure 28. The 25% risk map for wet years (May 1 to September 30 precipitation). Over the long term, one year in four will have this much or more precipitation.



Soil Water Status

While precipitation is an important parameter to agriculture, it does not adequately describe agricultural potential insofar as water requirements for crops are concerned. One must also consider the amounts of water actually required for plant growth. This depends upon climatic conditions. Rising temperatures, increased wind and reduced relative humidity for example, increase the water requirements for plants. Although data for wind speed and relative humidity are not readily available for most weather stations in Manitoba, daily temperature extremes are available. Researchers at the Agrometeorology section of Agriculture Canada in Ottawa have developed relationships which estimate potential evapotranspiration rates (the maximum water used by plants under ideal conditions) based on temperature and the solar radiation received at the top of the atmosphere.

These measures of soil water stress are calculated in mm of equivalent precipitation. For those who are uncomfortable with the metric system, there exists a very easy conversion from metric to English units. For all practical purposes, 25 mm is equal to one inch.

Soil Water Status for Forage Crops

Since perennial forage crops have an actively growing canopy for most of the growing season, the water used by these crops is approximately equal to the potential rate of evapotranspiration. So the soil water status in soil growing a perennial forage crop is calculated in the following way:

Soil water status at the end of Day 2 = soil water status at the end of Day 1—potential evapotranpiration during Day 2 + precipitation on Day 2.

The calculation begins on May 1, assuming there is 100 mm of readily available water in the soil on that date. Actually most soils have an available water holding capacity of about 200 mm to a soil depth of 90 cm. About half of this, or 100 mm, is readily available to plants. So decreasing soil moisture within this range has no detrimental effect on plant growth. Once the first 100 mm is used, the rate of plant growth drops. The crop is then considered to be in a stress situation and the soil water status takes on negative values. In other words, a soil water deficit exists. At weather stations located on predominant sandy soils, it's assumed 80 mm of water is available to plants.

There is, of course, no guarantee that all Manitoba soils are saturated to their capacity on May 1. Some, particularly in western Manitoba, may contain less than the 100 mm (80 mm for sandy soils) of readily available water. Then the soil water system, as calculated here, may be slightly higher than actually occurs in some years.

To simplify calculations, it's assumed the forage crop is alfalfa and two cuts were taken. The soil water status at the end of each cut has been calculated and mapped.

The average soil water status after the first cut is -25 mm for most of the province (Figure 29). This means, on the average, the alfalfa would require 25 mm of irrigation water to yield its maximum possible dry matter. Following the same reasoning, 50 mm of irrigation water would be required around Brandon for maximum production. The 25 per cent risk map shows that one year in four, most of the province could use at least 50 mm of irrigation to maintain maximum alfalfa production (Figure 30). The area south and west of Brandon would require 75 to 100 mm of irrigation water. The map showing the one in 10 year risk (Figure 31) has the same relative geographical distribution as the previous two maps.

After the second cut, the average soil water status is considerably lower than after the first cut (Figure 32). On average, most areas in the province would require 125 mm of irrigation water to sustain maximum alfalfa production on the second cut. Up to 175 mm would be needed in the southwest corner of the province. To protect himself against the one in 4 year risk, a farmer would have to provide 175-225 mm of irrigation water to maintain maximum production for the second cut (Figure 33). The one in 10 year risk map shows that same relative geographical distribution as the previous two but the soil water status is lower (Figure 34).

The studies of the soil water status indicate soil water is not a serious limitation for first cut alfalfa in a good part of the province. To maximize the second cut, rather large amounts of irrigation water are required. This does not necessarily mean farmers interested in alfalfa production should purchase an irrigation system. That decision will depend upon the risk of drought in the area and numerous economic considerations. It does mean water is a serious limiting factor, particularly for second cut alfalfa.

Figure 29. Average Soil Water Status (mm) after the Frist Crop of Alfalfa.

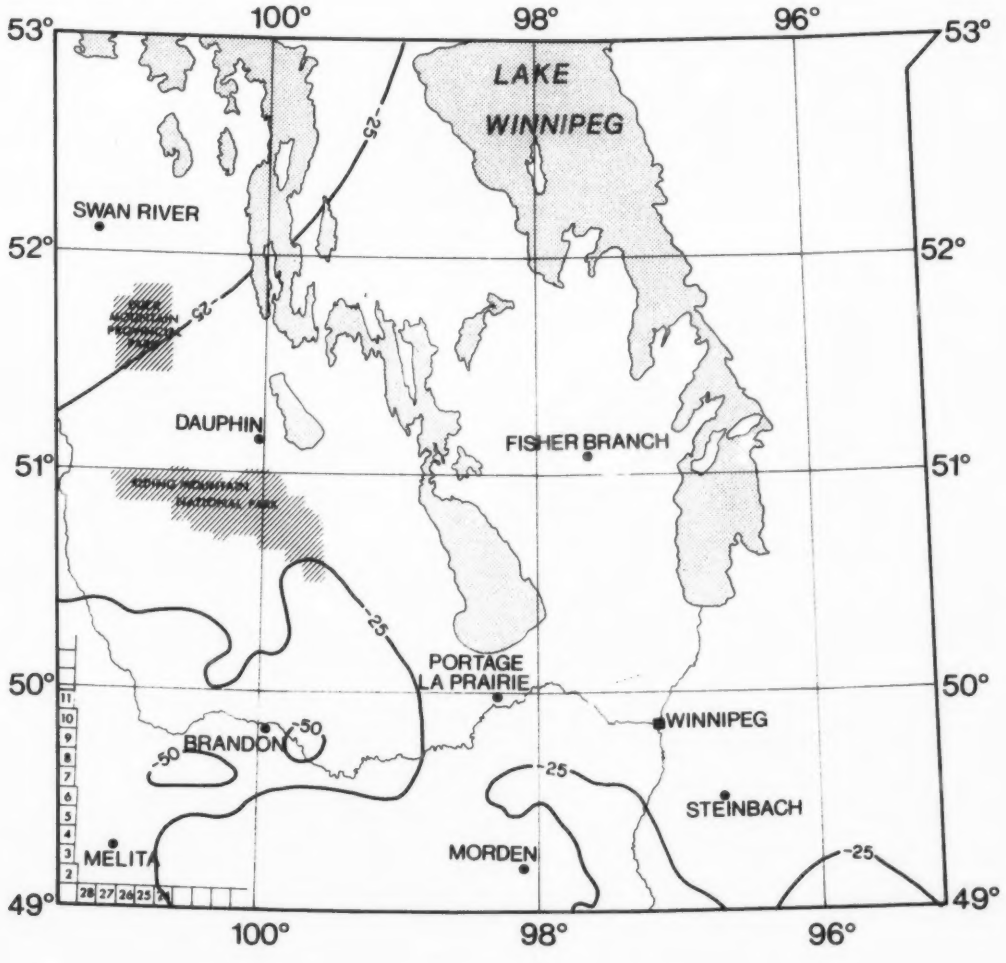


Figure 30. Soil Water Status (mm) after the First Crop of Alfalfa which can occur with a 25% risk.

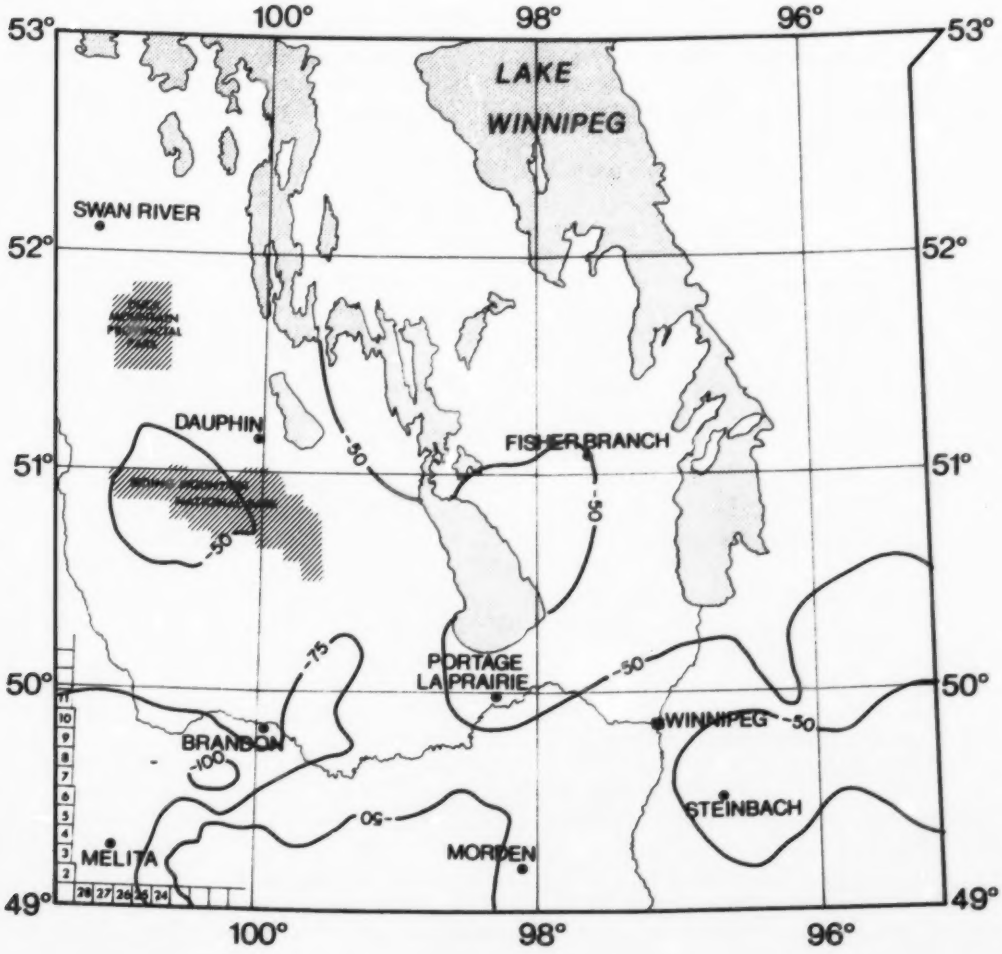


Figure 31. Soil Water Status (mm) after the Frist Crop of Alfalfa which can occur with a 10% risk.

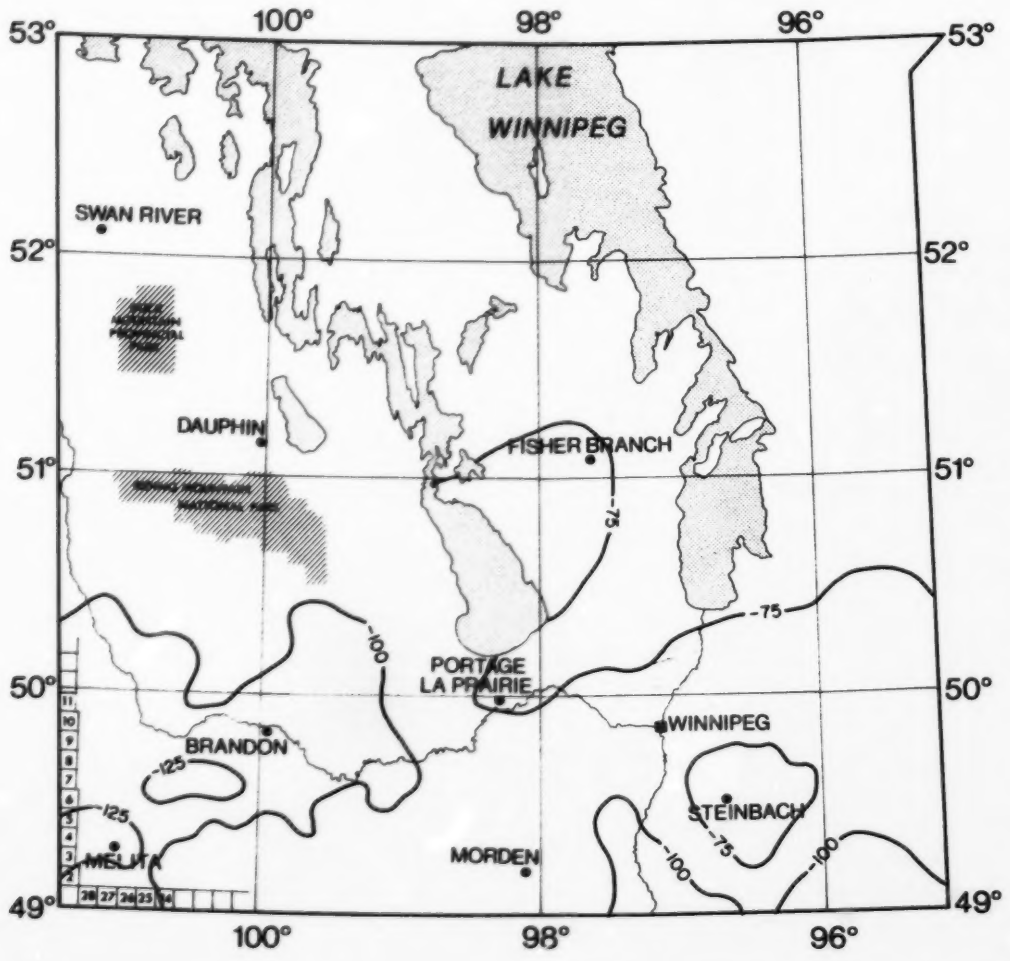


Figure 32. Average Soil Water Status (mm) after the Second Crop of Alfalfa.

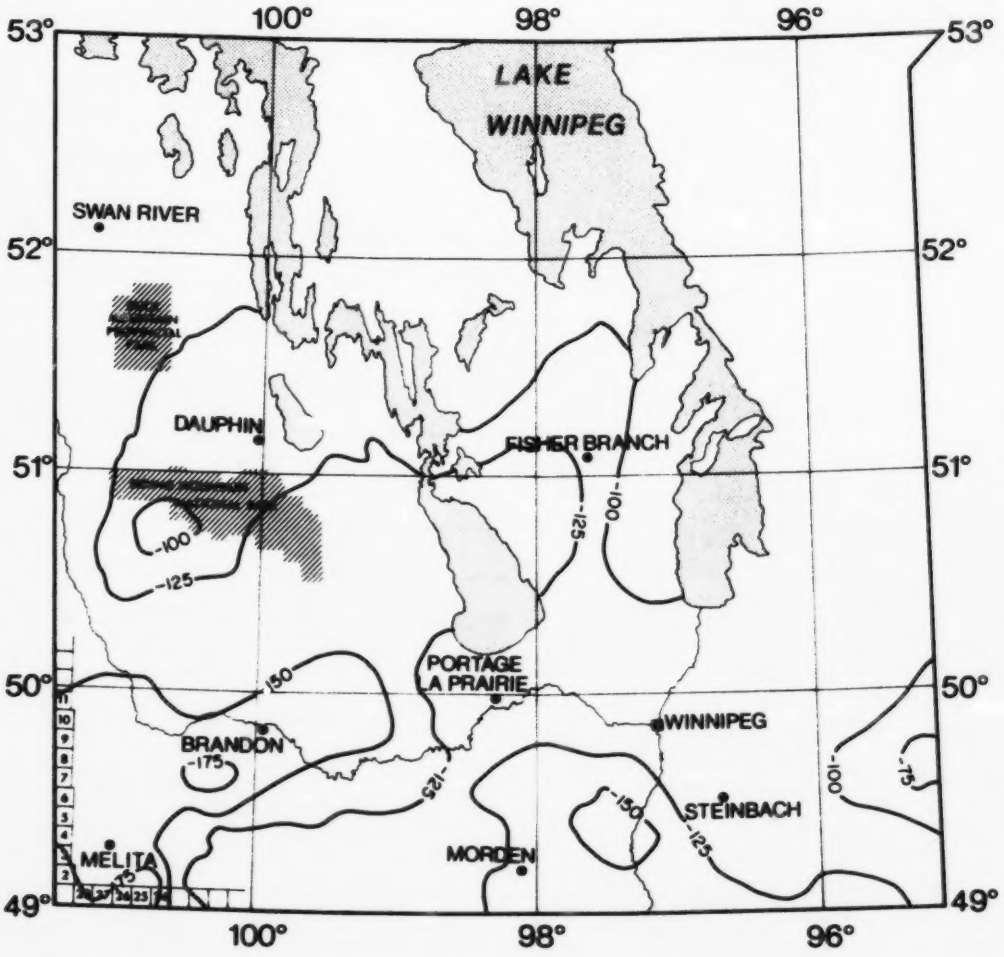


Figure 33. Soil Water Status (mm) after the Second Crop of Alfalfa which can occur with 25 % risk.

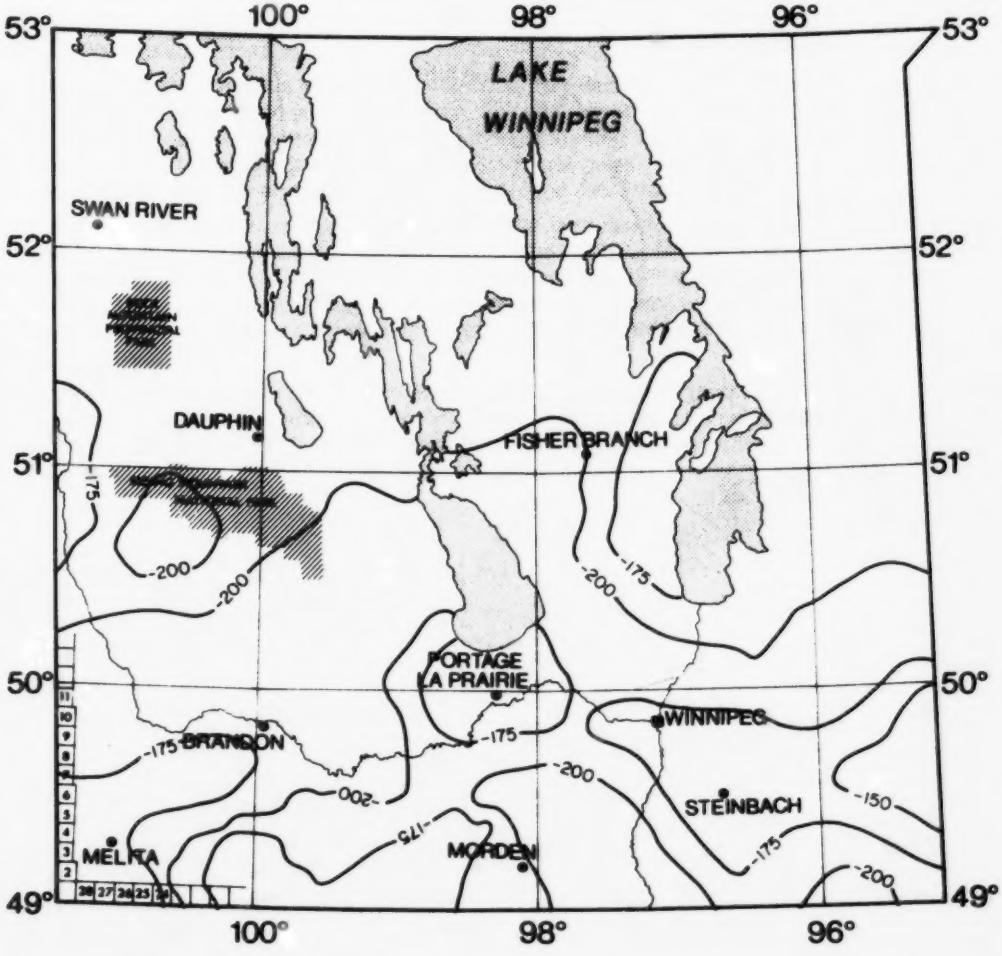
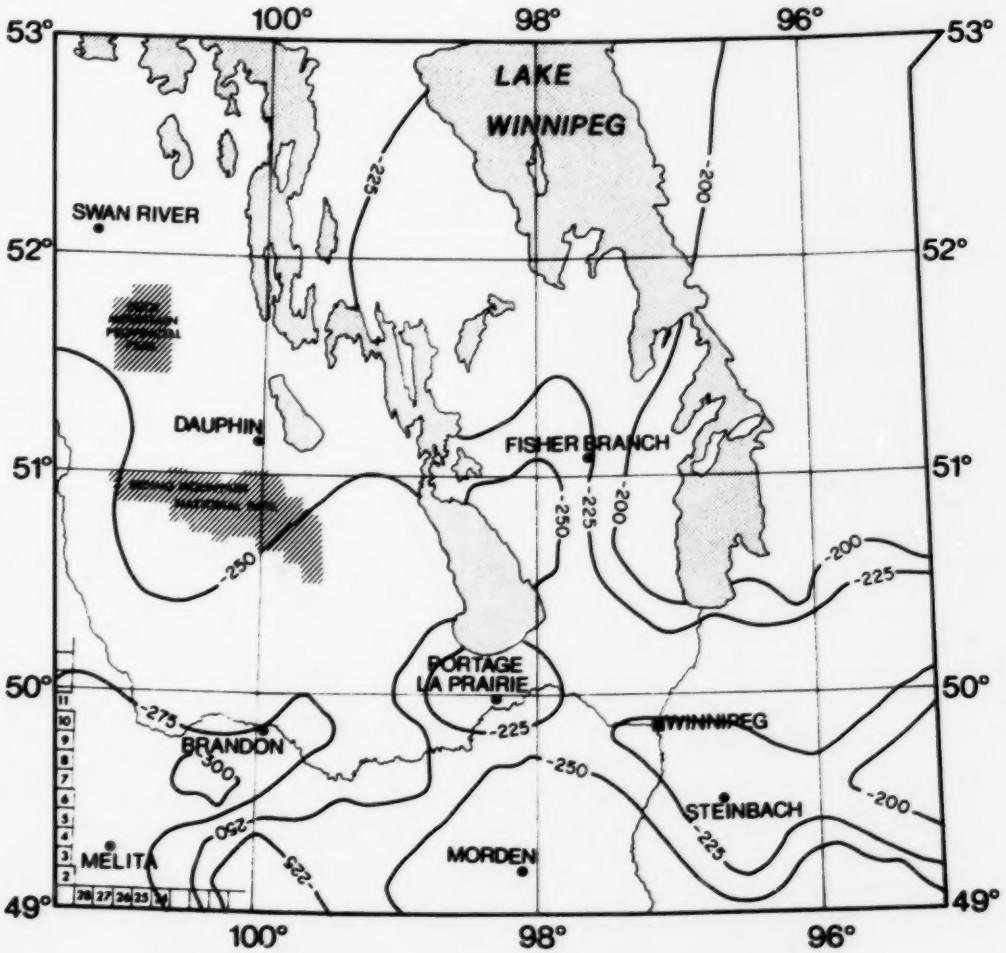


Figure 34. Soil Water Status (mm) after the Second Crop of Alfalfa which can occur with a 10% risk.



Soil Water Status Under Cereal Crops

While soil water use is about equal to the potential evapotranspiration for a forage crop under ideal conditions many other crops use less water. Cereals and some special crops such as canola and flax fall into this category. With these crops, the rate of water use at the beginning of the season is very low, perhaps 30 per cent of potential evapotranspiration. As the crops grow and leaf area increases, the rate of water use increases. As soon as the leaves provide complete ground cover the rate of water use equals potential evapotranspiration. It remains at this level until the crop begins to mature at which time water use drops off rather rapidly.

The ratio of maximum water use to potential evapotranspiration is called the "*consumptive factor*". The value of this factor at different stages of crop development has beeen determined experimentally and is well known. To calculate water use by a cereal crop at a particular stage of development one simply multiplies potential evapotranspiration by the consumptive use factor for that stage of development. Thus the soil water status under cereal crops is determined by:

Soil water status at the end of Day 2 = soil water status at the end of Day 1 – (consumptive use factor × potential evapotranspiration during Day 2) + precipitation on Day 2.

All the other assumptions made in the calculation of soil water status remain the same.

Numerous research projects indicate the most serious effects of a drought on cereal crop yields occur during the heading to soft dough stage. For this reason, soil water status was calculated at the end of the soft dough stage on wheat. Strictly speaking this is not applicable to all cereals, canola and flax, but at the same time the error is not great. The convenience of being able to use a single map for all cereals greatly outweighs the error involved.

In general, soil water status at the soft dough stage is quite favorable (Figure 35). Over much of the province, there is no water stress. That is, the value of soil water status is near zero in most areas. Based on this analysis, one can conclude that in these areas in an average year soil water status is about optimum, and there would be no response to irrigation. A small area around Morden and the southwest corner would require 25 to 50 mm of irrigation water to eliminate stress.

Looking at the one in 4 year risk map, one sees about 50 mm of irrigation is required to eliminate water stress in most of Manitoba (Figure 36). Again the southwest corner requires slightly more. The one in 10 year risk map shows the same relative distribution as the previous two maps, but the level of water stress is slightly higher (Figure 37).

Figure 35. Average Soil Water Status (mm) at the Soft Dough Stage in Wheat.

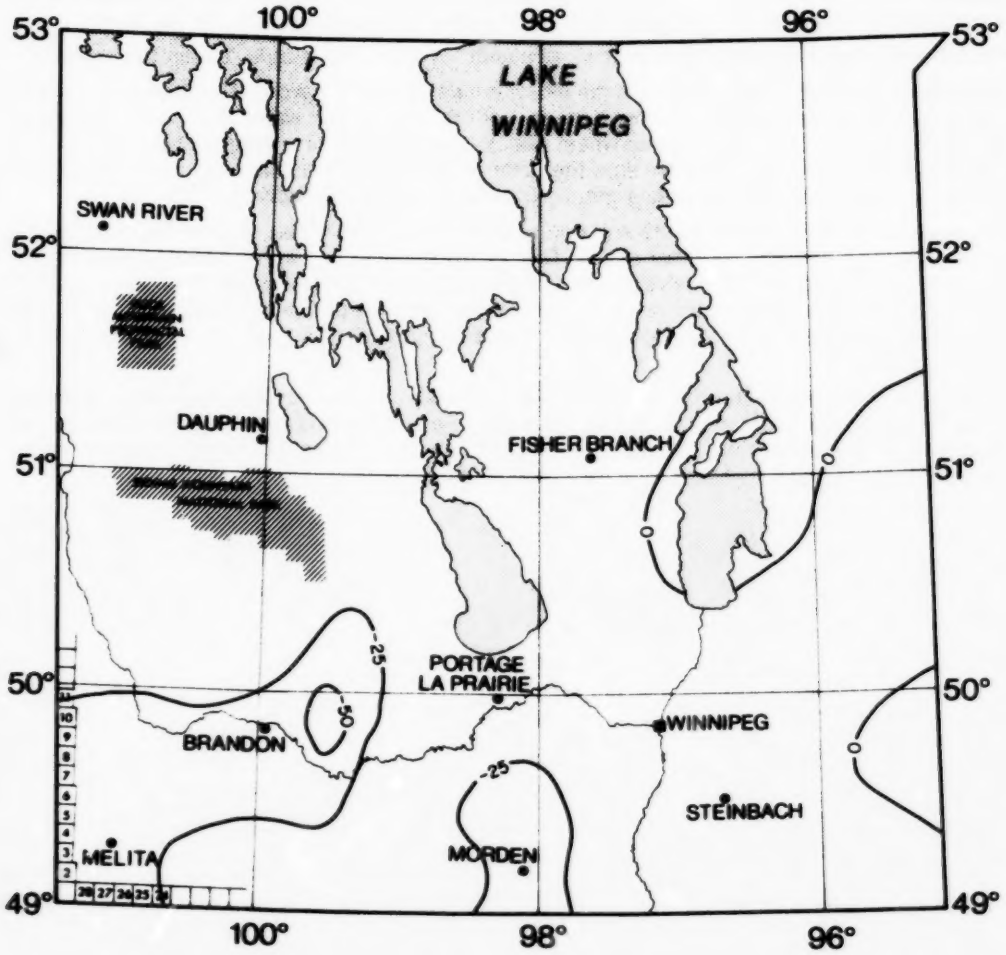


Figure 36. Soil Water Status (mm) at the Soft Dough Stage in Wheat which can occur with a 25% risk.

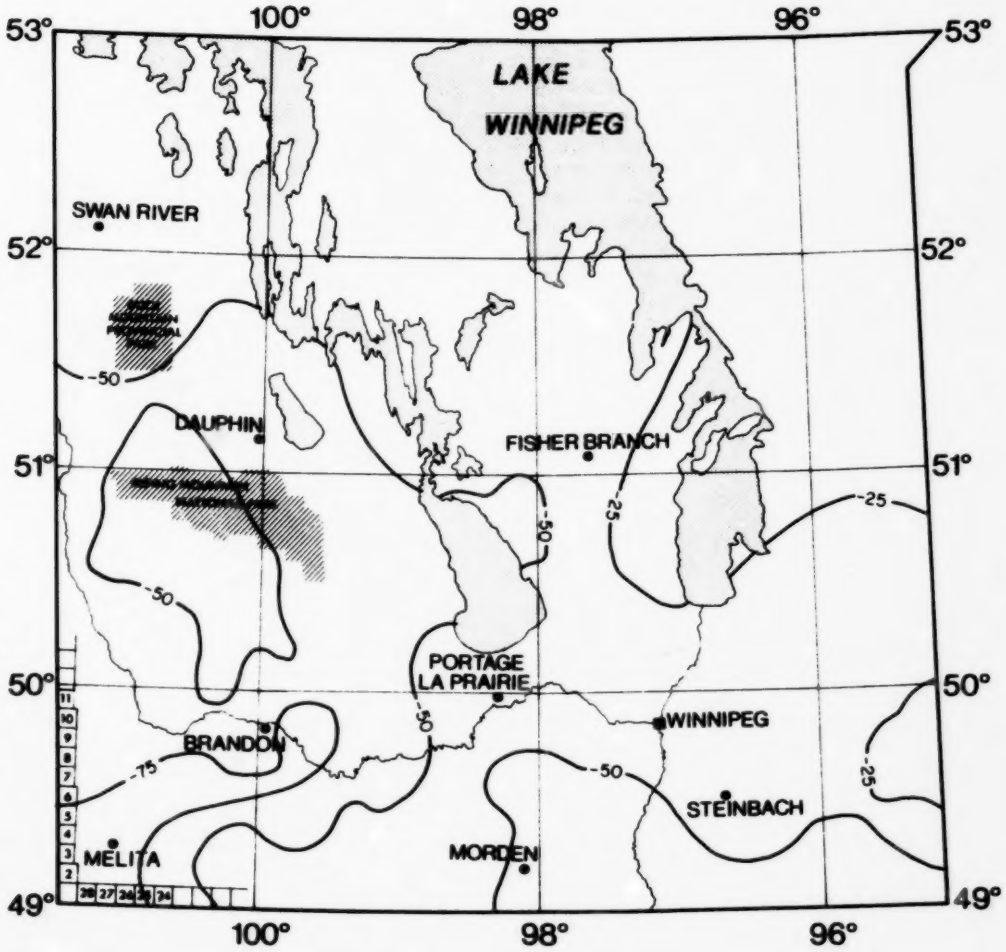
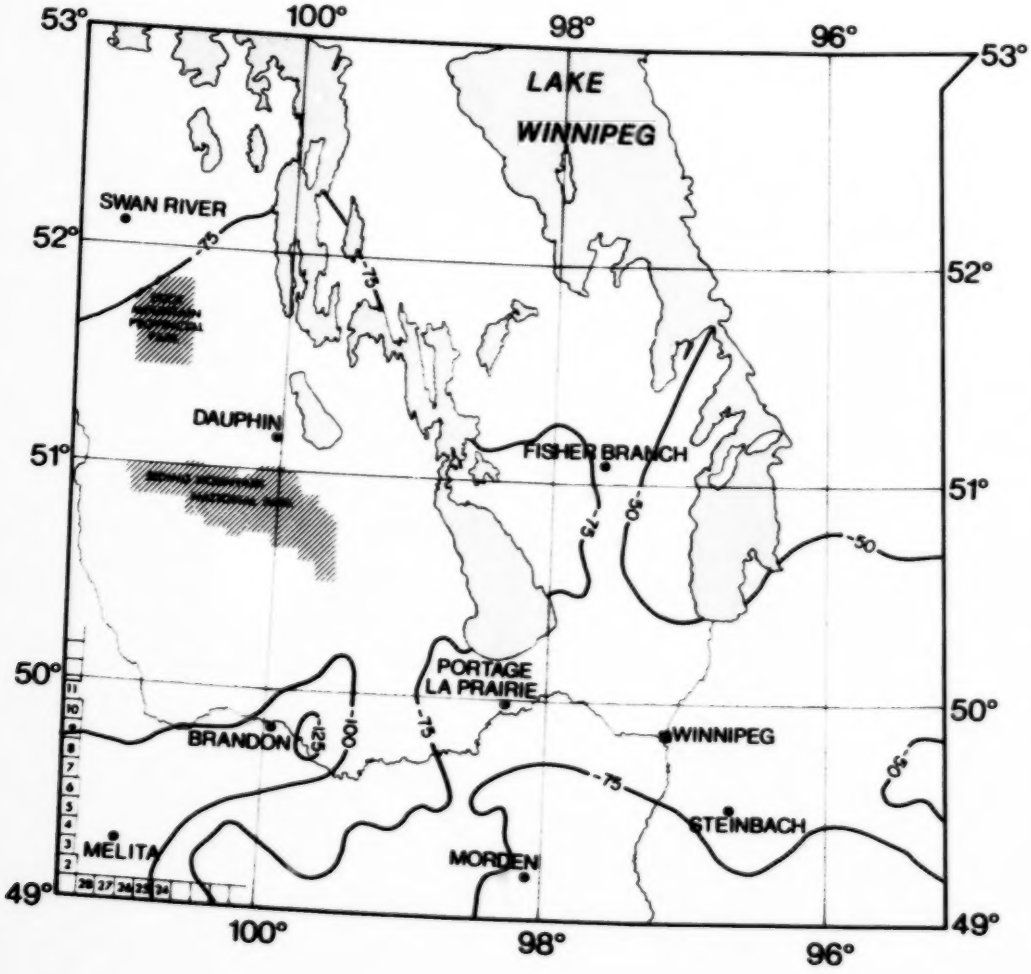


Figure 37. Soil Water Status (mm) at the Soft Dough Stage in Wheat which can occur with a 10% risk.



Soil Water Status Under Long Season Crops

In some crops water use patterns differ from those with perennial forages or cereal crops. These long season crops include potatoes, corn and sugar beets. An important characteristic of these crops is that their water use resembles that of cereal crops early in the season, and resembles that of perennial forage crops late in the season. Water use by these crops is about 30 per cent of potential evapotranspiration early on, reaches 100 per cent potential evapotranspiration at complete ground cover, and remains at 100 per cent almost until maturity.

The rate of water use can be described quantitatively. But the question remains as to the time in the growing season when an estimate of soil water status is most useful. Although there are variations from crop to crop, research indicates yields are affected most by lack of water when harvestable fruit is being formed. Thus the yield of grain corn is affected most by lack of water at silking; potatoes during tuber set, and so on. As a compromise to this dilemma, it was decided to calculate water stress for these crops at the silking stage in corn.

The map on average soil water status values at silking shows much of the province has a value of 25 mm (Figure 38). As this is a positive number maximum yield would be obtained without irrigation under average conditions. Even at the rate of 25 per cent risk level, most of the map has a soil water status of zero, so no water stress exists (Figure 39). If a farmer wishes to protect himself against the one in 10 year risk, in most of Manitoba, he should have the capacity to provide 25 to 50 mm of irrigation water (Figure 40).

Maps showing soil water status at silking in corn have important implications. Over much of Manitoba, irrigation would only increase yield in one out of four years. This makes it doubtful that irrigating crops such as corn is economically feasible. Only in special circumstances such as where soils are very sandy and the water holding capacity is very low, should irrigation be considered.

Figure 38. Average Soil Water Status (mm) at Silking in Corn.

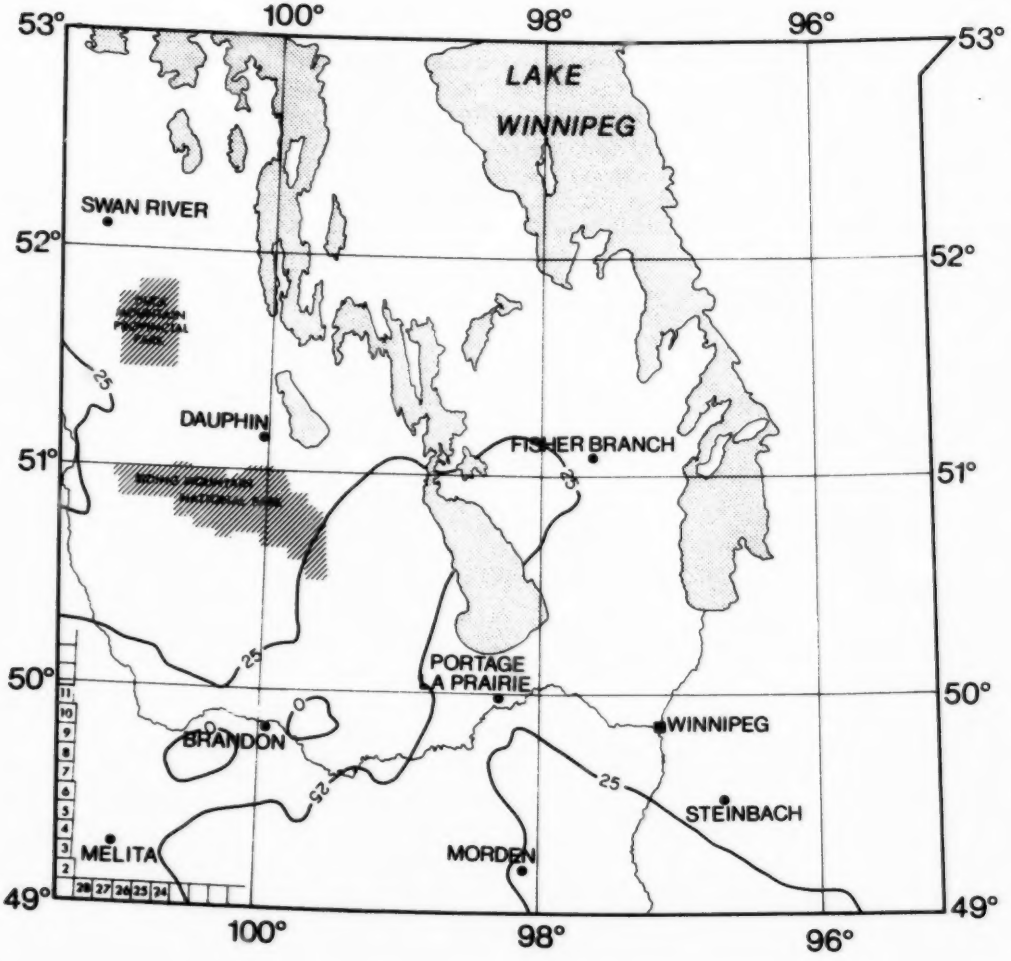


Figure 39. Soil Water Status (mm) at Silking in Corn which can occur with a 25% risk.

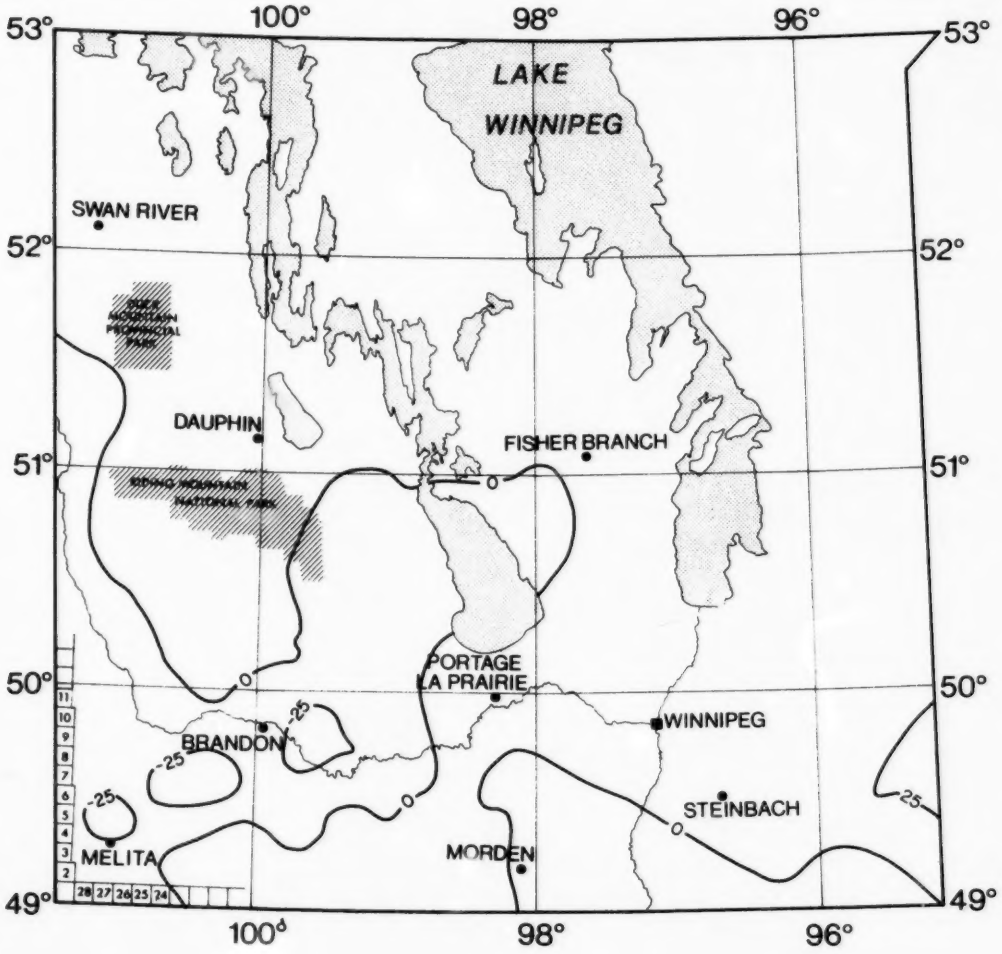
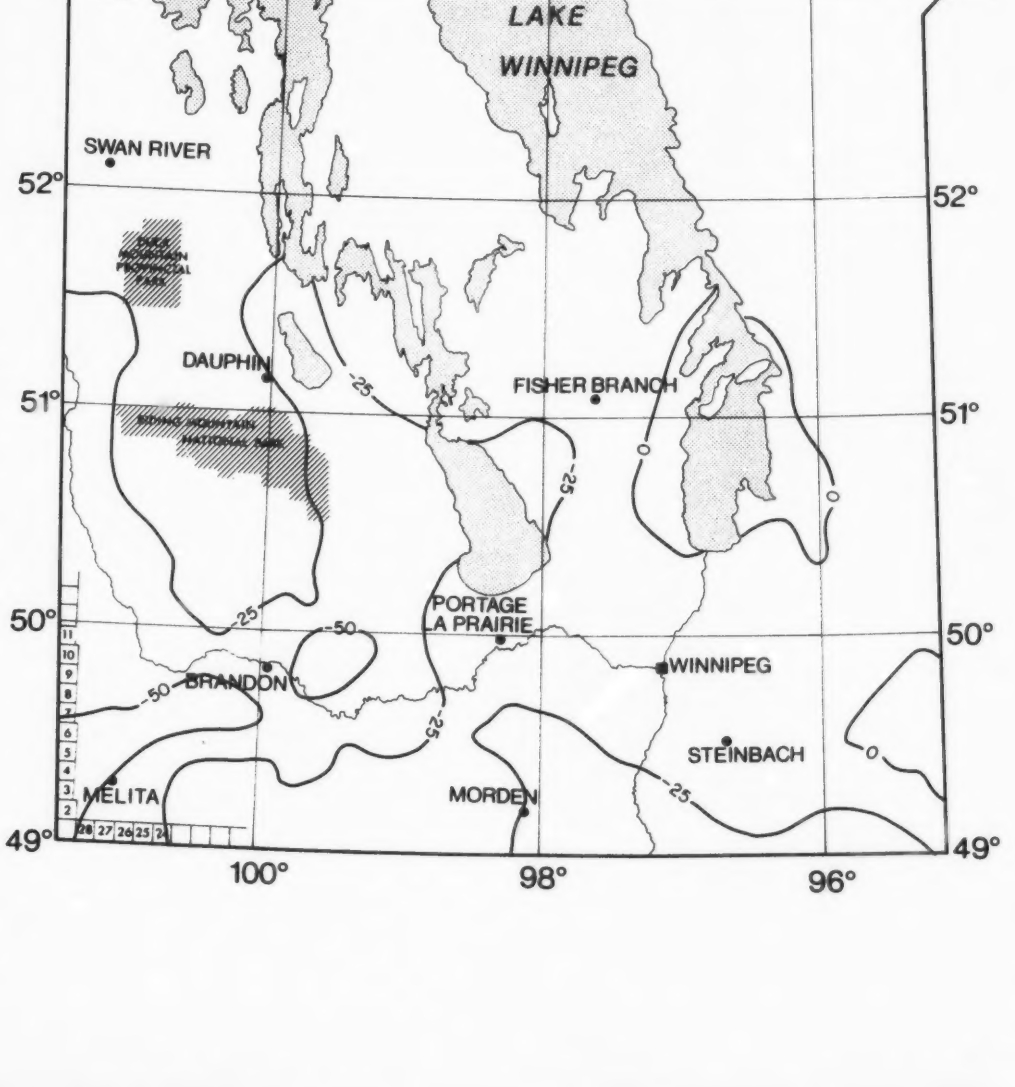


Figure 40. Soil Water Status (mm) at Silking in Corn at 10% risk.



POOR

QUALITY

ORIGINAL